2021 TECH PREVIEW All the good stuff coming

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MARCH 2021 #491

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MAKE YOUR OWN AI ASSISTANT & MORE

The future of home networking

FROM THE STATE OF PLAY TODAY, TO TOMORROW'S Wi-Fi WONDERS & THE SMARTER HOMES WE'LL ALL ENJOY

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- 1 x USB 2.0 port for 3G/4G LTE USB modems, FTP server, network printer or thermometer
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EDITORIAL

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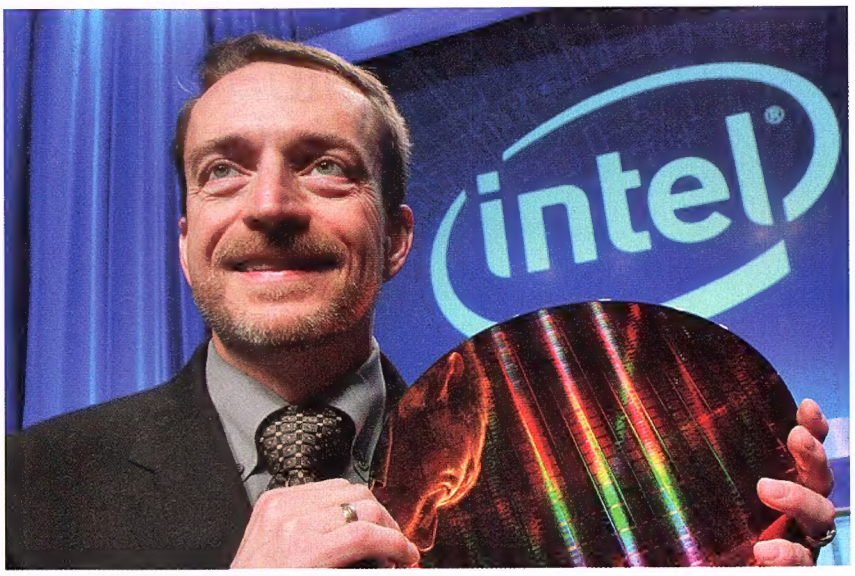

EDITORIAL

Blue's music

Intel is getting the band back together again.

It feels like we've been talking about Intel a lot, lately. And there's no denying it. But what's a PC mag editor to do when the last year or two has seen one of the biggest names in PC undergo such a dramatic swing? As enthusiasts, you too are likely as intruiged as I am to see what will happen over the next couple of years.

And right now the picture is a whole lot rosier, ever since the recent appointment of Pat Gelsinger as the company's new CEO. Pat's an engineer, and that's exactly what the company needs at the helm to move forward. In the fight against AMD over the last year Intel hasn't responded with notably better products than its arch enemy, instead offering up the usual incremental improvements, with the overall product stack now awash with new and expanded product families and product names that just create confusion. The best of Intel, lately, has been its 11th gen Tiger Lake mobile CPUs, but AMD Mobile Ryzen 4000, and now 5000, have brought the fight right back.

"We all look forward to seeing a new energy and enthusiasm from the company."

The worst of Intel in 2020 was a series of PR blunders that saw, most notably, two ill-willed private media presentations that simply didn't promote its own products – one was entirely dumping on one of AMD's methods of measuring power consumption, and the other was trashing the benchmarks that we, and the rest of the tech media, use and have used for years.

It reeked of defensive do-somethingism. As if the company didn't have anything good to say about its own stuff, so instead made noises about what it percieved as independant reviewers not appraising Intel's products properly, and if only we'd change our testing to use methods that paint Intel in a better light.

Well, Pat, we're all expecting you to do better. You know – we all know – it's a long road ahead, and that engineering, not PR, is the way forward.

The recent hire of former Intel lead architect Glenn Hinton is another really positive sign that the band is getting together again to do great things. If a legend like Hinton is prepared to come out of a very comfortable retirement for this challenge, that inspires genuine confidence and we all look forward to seeing a new energy and enthusiasm from the company.

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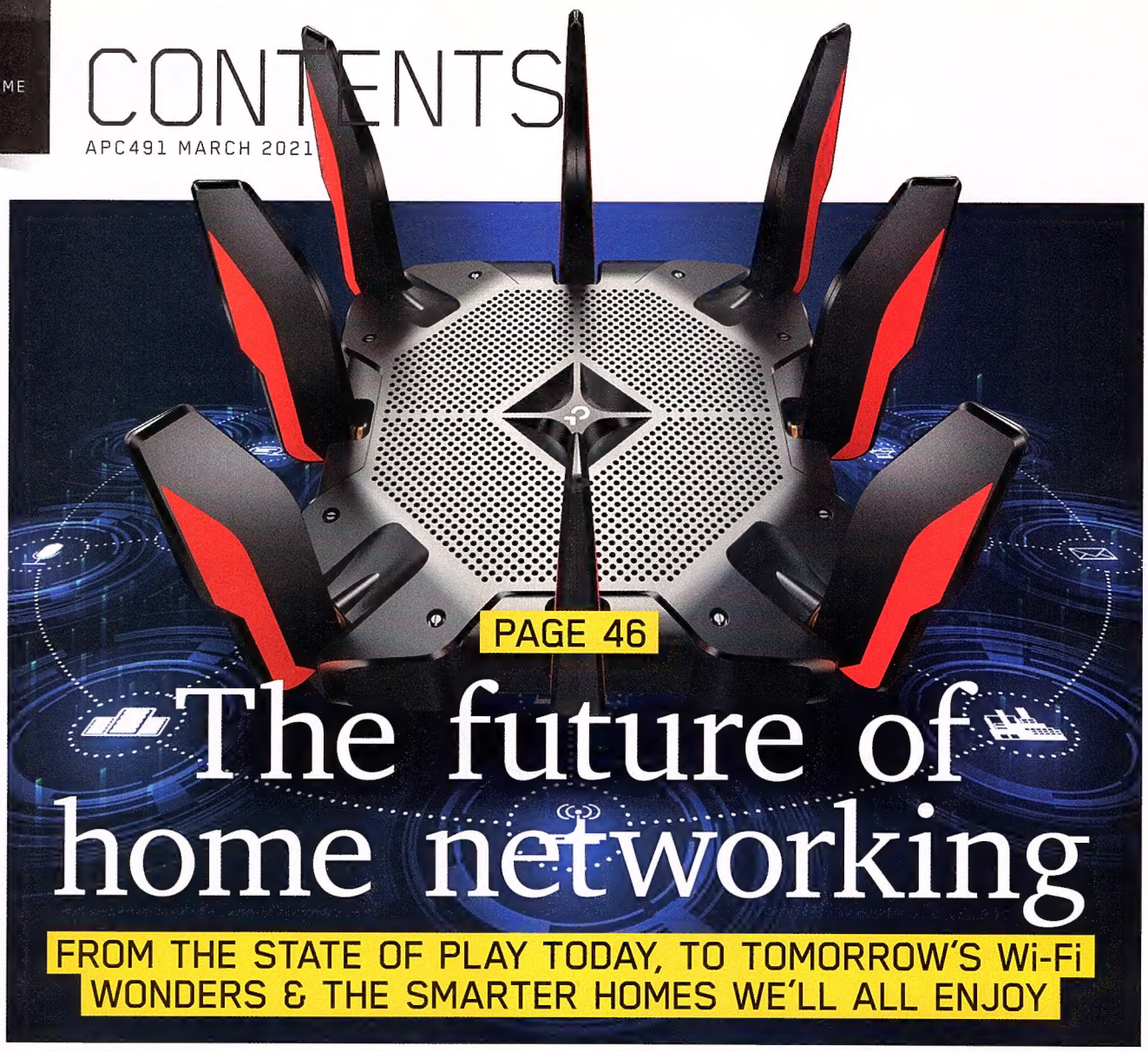

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You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

Inside *APC*

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

"APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible."

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

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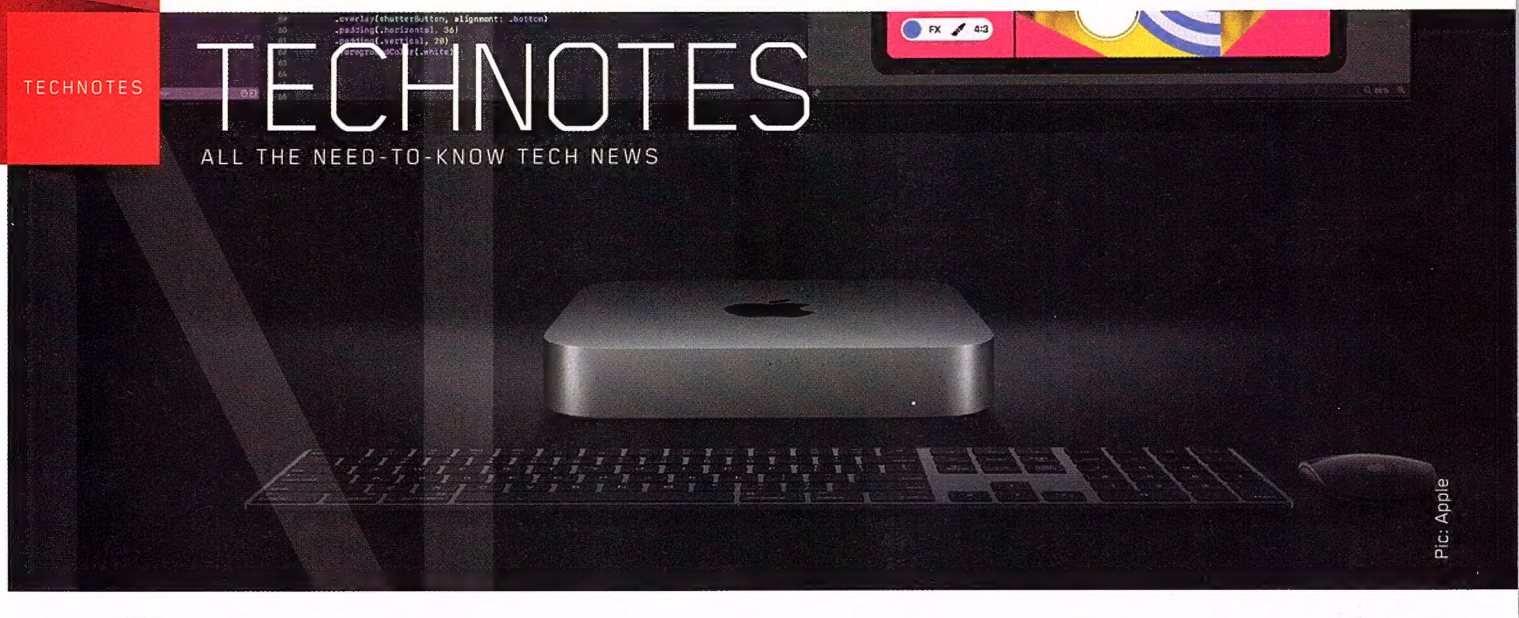
TECHNOTES

ALL THE NEED-TO-KNOW TECH NEWS



Pic: Apple

CHIPS

Apple: Mac Mini M1 consumes 3X less power than Intel

Drastically cuts down power consumption of Mac Mini desktop with M1 SoC.

Just in case you've ever wondered how much your shiny new Apple Mac Mini featuring the M1 SoC consumes in a burn-in test scenario, Apple has disclosed its own official data, and it's impressive.

Apple finally published its official M1-based Mac Mini power consumption numbers showing that the unit consumes approximately just a third of its Intel-based predecessor's power. When Apple announced the transition to its own system-on-chips, it explained the move with performance, features, and power efficiency its SoCs can deliver without giving away any numbers. Then the company demonstrated some impressive performance figures for its M1-based MacBook Pro machines when it launched them but omitted any direct power-related details.

The beefed-up 2020 Mac Mini M1 consumes 39W under high load, whereas the beefed-up 2018 Mac Mini with a six-core Intel Core i7 inside can pull 122W of power under load. At idle, a 2020 Mac Mini sucks 7W, whereas its predecessor devours 20W of power.

Power consumption of the whole system counts in consumption of all of its components, including memory, storage, connectivity controllers (with the new Mac Mini, we're talking about a bunch of chips that includes Apple's own Wi-Fi/Bluetooth (and GbE controller) as well as voltage regulation overhead. Apple's measurements are significantly higher than those obtained by *AnandTech*, which means that Apple indeed uses a burn-in test that stresses all parts of the system, something that arguably happens in many real-world situations.

In fact, as far as power efficiency is concerned, the 2018 Mac Mini is the most power-hungry Mac Mini ever. Yet it was a quite powerful machine for its time. In fact, with up to 64GB memory onboard, it can still outperform the new M1-based Mac Mini in memory-intensive workloads, which ironically do not really require a lot of CPU horsepower at all times, and therefore its power draw in those workloads will not hit the ceiling demonstrated by Apple's test.

One of the interesting parts of the comparison is not exactly Apple's M1 vs Intel's previous-generation CPUs. It is against Apple's very first generation of Mac Mini based on the single-core G4 processor based on the Power microarchitecture. That model consumed 32W in idle mode and 85 Watts while being active.

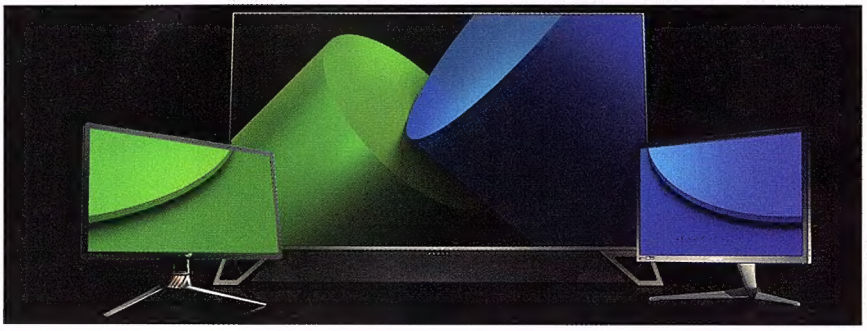
Microsoft Word and Outlook are getting a major dictation improvement

With promises not to store your audio recordings.

Microsoft is improving the dictation function for both Word and Outlook. The dictation improvements are currently in development and are expected to begin rolling out in March.

"Dictation has [a] new UI and settings to control a profanity filter and automatic punctuation," the Microsoft 365 roadmap explains. "Voice commands make editing and formatting your dictated text easier than ever."

A significant change accompanying the dictation update is the addition of a new dictation toolbar. In order to access the toolbar, users can click the 'Dictate' button on the Home tab or press Alt+`. Through the toolbar, users will gain access to all the standard dictation features, as well as the ability to change settings like language and automatic punctuation.



Pic: Nvidia

Nvidia clears up G-Sync ultimate confusion

Explains what 'lifelike' means.

Recently, Nvidia brought some confusion to those shopping for the best gaming monitors when it quietly changed the G-Sync Ultimate requirements listed on its website. In January, Nvidia changed the description, saying that G-Sync Ultimate monitors have "the top Nvidia G-Sync processors to deliver the very best gaming experience, including lifelike HDR." But what exactly does "lifelike HDR" mean? An Nvidia representative since confirmed that G-Sync Ultimate monitors require:

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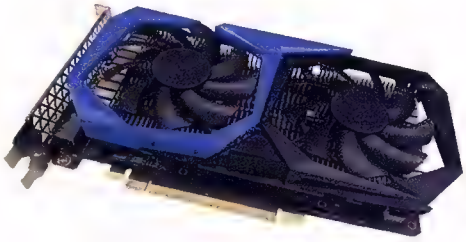
Windows 10's next major update could arrive much later than hoped

Feature update 21H1 might not be here until June.

Windows 10's next feature update might arrive later than the first upgrade of the year normally would, at least according to the latest leak.

Windows 10 21H1 could pitch up in June, according to a Chromium code commit from a Microsoft software engineer, which read: "The Windows Release coming out this June 2021 has a new API that can disable KTM exploits."

This must refer to the 21H1 update, rather than the second update for 2021, as June is (just) in the first half of the year, whereas the following update turns up in H2 (obviously); and indeed usually later in H2 (September, October or November), as well.



Pic: Intel/Colorful

Intel's first Xe graphics card only works with Intel CPUs and motherboards

UEFI BIOS support limited to four low-end chipsets, with not a sniff of AMD CPU support.

Intel's new DG1-based Iris Xe graphics card is only compatible with Intel motherboards and CPUs. The news comes days after Intel revealed the first Xe graphics cards produced by board partners and due to be sold in retail PCs.

According to *Legit Reviews*, specific UEFI BIOS support is required to run the new graphics cards. An Intel statement explained that, "the Iris Xe discrete add-in card will be paired with 9th gen (Coffee Lake-S) and 10th gen (Comet Lake-S) Intel Core desktop processors and Intel B460, H410, B365, and H310C chipset-based motherboards and sold as part of pre-built systems. These motherboards require a special BIOS that supports Intel Iris Xe, so the cards won't be compatible with other systems."

Glenn Hinton • 3rd+
Intel Sr Fellow
1d •

After enjoying a real retirement for 3 years I have decided to go back to work at Intel (where I previously worked for 35 years). What would entice me to do something like that? I will be working on an exciting high performance CPU project. Having Pat Gelsinger coming back as CEO also helped me finalize my decision to come back.

932 · 103 comments

Pic: Glenn Hinton

HERE COMES THE CAVALRY

Intel's 'high performance CPU project' tempts noted engineer out of retirement

Bolstered by Pat Gelsinger's CEO appointment, Glenn Hinton is heading out of retirement and back to Intel.

Another Intel lifer is returning to the fold following the announcement of Pat Gelsinger's appointment as CEO. Glenn Hinton, lead architecture of the Intel Nehalem architecture, is stepping out of retirement to return to the company for an "exciting high-performance CPU project."

Hinton announced his return on LinkedIn, citing Pat Gelsinger's return as Intel CEO in February as the final push to return to Intel after three years in retirement and having been considering the new role since November. Oh, and the promise of an upcoming CPU project from the chip company that appeals to Hinton's sensibilities.

"If it wasn't a fun project I wouldn't have come back," Hinton goes on to reply to a comment.

As lead architect for the Nehalem CPUs during a 35-year stint at Intel, Hinton previously oversaw Intel's most significant and lasting architectural overhaul. That architecture formed the basis for the Core processor line-up still in operation today, and marked a major shift from Intel's previous escapades attempting to reach high clock speeds with Pentium 4.

The architecture proved successful back when it launched in 2008, and continued success allowed Intel to maintain a steady lead in the CPU industry for most of the decade.

Intel kills off all Optane-only SSDs for consumers

All Optane SSDs for desktop PCs discontinued.

In a surprising move with little fanfare, Intel announced that it is discontinuing all of its Optane-only SSDs for the consumer market. Surprisingly, the company says those drives aren't going to see Optane-only replacements, marking the end of its enthusiast-geared Optane SSDs for desktop PCs.

Intel discontinued the Optane Memory M10, 800P, 900P, and 905P SSDs, representing the entirety of its Optane-only family for desktop PCs. Intel's 900P and 905P discontinuation notice states:

"Intel will not provide a new large capacity Optane Memory SSD as a transition product for the client market segment. Intel will focus on the new Optane Memory H20 with Solid State Storage for the client market segment."

Intel's discontinuation period is incredibly brief, too, with all discontinued drives no longer offered as of the publication date of the notices. ■

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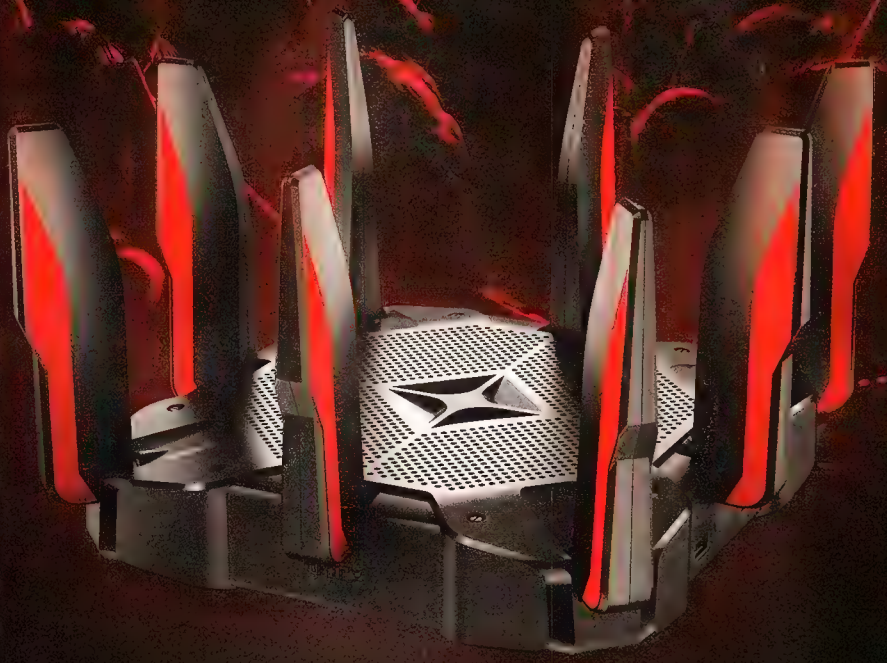
STILL DOMINATING THE COMPETITION



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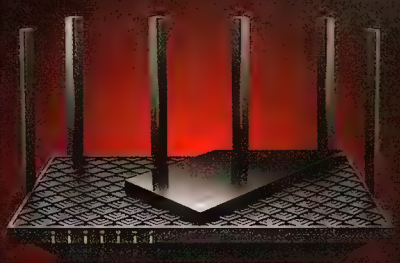

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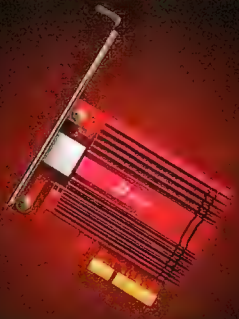

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TECH BRIEF

Why Pat Gelsinger will kick Intel back into shape

Return of the engineer.

Pat's back and it couldn't be better news for Intel. And what's good for Intel is usually good for the PC. The 'Pat' in question? That'll be Pat Gelsinger, Intel's freshly minted CEO and an engineer through and through. If anyone can fix Intel's problem, it's Gelsinger, right?

The financial markets seemed to think so, with Intel's share price immediately jumping seven percent on the news. For journalists of a certain age, of course, Gelsinger is best known as the beaming, relentlessly upbeat face of the Intel Developer Forum, the now-defunct engineering focussed trade fair otherwise known as IDF and a throwback to an age where Intel was the unambiguous world leader in chip technology.

Gelsinger's last tenure at Intel lasted fully 30 years ended in 2009, at which point he had risen to Chief Technology Officer and overseen Intel's resurgence to total market dominance with the Core architecture in the mid 2000s. Lest you have forgotten, the smash hit Sandy Bridge family of CPUs was released in 2009, just as Gelsinger's Intel tenure was ending.

Such are the lead times involved in chip production, Gelsinger's fingerprints were all over Intel's CPUs for several years hence. It's very likely even Skylake, another smash hit and the architecture that still underpins Intel's current desktop and server processors, is essentially a product of the Gelsinger era.

For what it's worth, Gelsinger is also widely viewed a both a brilliant engineer and one of the good guys. More recently, of course, Intel has been struggling. To be clear, Intel remains by far the biggest beast in PC processors. It's hugely profitable and can barely keep up with the demand for its x86 CPUs, particularly for the server computers that power the internet, the cloud and other enterprise applications.

But Intel's well publicised problems with its previous world-beating chip production technology are beginning to do real damage. Intel's 10nm node is at least five years behind schedule, an eternity in an industry used to technological advancements so regular and reliable, they spawned the notion of Moore's Law, the idea that transistor density in computer chips doubles every two years.

Things are bad enough that Nvidia overtook Intel as the US's largest chip maker back in July, a very significant milestone. At the same time, many observers reckon Intel has become far too marketing led. The symptoms of that are widespread, including the often baffling structure of its product line ups and branding seemingly designed to befuddle even the most committed technophile, never mind typical consumers buying PCs and laptops.

Put simply, Intel needs to get its house in order, and fast. It's that fast bit that might be the problem for Gelsinger. Intel remains a publicly listed company, so our main doubts don't involve Gelsinger's abilities but rather the market's propensity for actually giving him a chance. Intel is a huge ship and it will take years to turn. With analysts picking Intel's performance apart quarter by quarter, month by month, week by week, the question is whether Gelsinger will be given enough time to make a real impact.

Engineering-led solutions in particular will take an awfully long time to deliver. But engineering solutions are what Intel desperately needs. Realistically, the next five years are already largely baked in from an engineering and product perspective. It'll only be after that kind of time frame that we'll see the full impact of Gelsinger's influence on the chips inside our PCs. If he can survive that long, the future for Intel and for the PC in general could be very bright indeed.

JEREMY LAIRD ■

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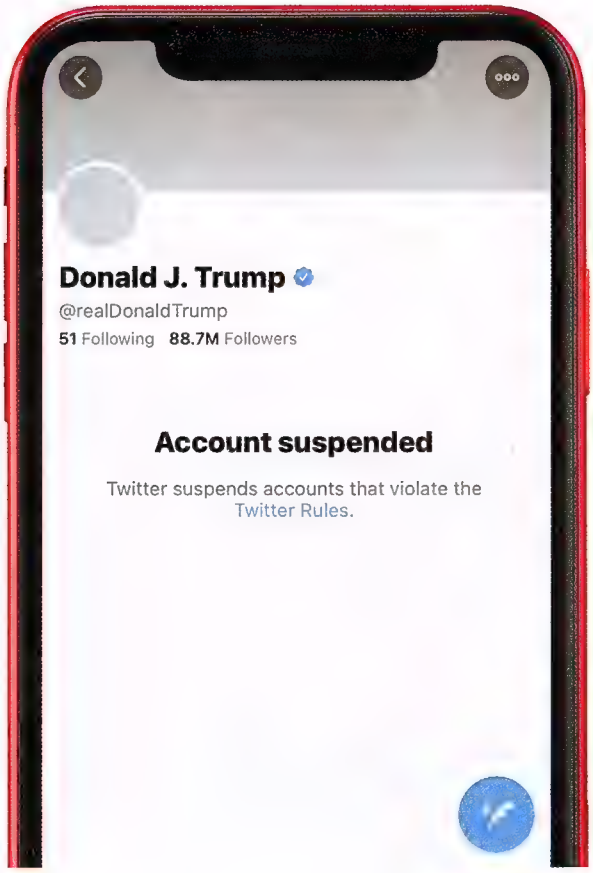


END USER

Twitter bans Trump, wonders if it should have

Social media and politics are a complex, toxic partnership, writes Shaun Prescott.

When Twitter adoption picked up pace in 2007 it was a pretty benign place. I remember it being a haven for *Simpsons* jokes and the idle musings of deskbound workers. Occasionally someone would get angry about something – like how slow their internet was, or how average a movie is – but even that seemed fairly rare: it very much felt like a networking tool back in those days, albeit a fairly freewheeling one. It was boring and it sucked. When people started to get angry on it, *that's when it got good*, or worse, depending on your own attitudes.

How things change. On January 8, 2021, Donald Trump is president (but not for much longer). Capitol Hill has been stormed by his supporters (as well as a gaggle of far-right and white supremacist hangers-on) in protest of the so-called "fake election" won by a Joe Biden-led Democrat party. But that's not even really the weirdest thing about it all, in retrospect. The weirdest (and let's admit: funniest) thing about the whole affair is that the President of the United States of America got banned on Twitter. He joins Alex Jones, Martin Shkreli, the American Nazi Party and rapper Talib Kweli.

The official Twitter blog made the announcement two days after the Capitol Hill event, on January 8. Its justification rested on the possibility that two of Trump's tweets incited or condoned the attempted insurrection. Of course, Trump did not tweet: "Storm the Capitol!" But in the lengthy blog post the platform holder states its case reasonably well: In the end, there was ground to believe that "the two Tweets... are likely to inspire others to replicate the violent acts that took place on January 6, 2021, and there are multiple indicators that they are being received and understood as encouragement to do so."

Trump was banned only days before surrendering his presidency, so you could cynically conclude that Twitter had timed the banning wisely: who wants to ban a standing president? With the methodology used to justify Trump's eventual ban, the ban could arguably have been months, years ago. But Twitter has a "public interest framework" that doesn't *protect* world leaders on it's platform per se, but wisely acknowledges that the situation is different compared to, say, @rexlikessex69 posting looped porn vids on the timeline. Bans for world leaders can come from "promotion of terrorism", "threats of violence" and other slightly less likely causes.

Banning Trump hasn't pleased everyone obviously, and even Twitter CEO Jack Dorsey was philosophical about it, wondering aloud if the platform had done the right thing. In a long thread, he wrote "the check and accountability on this power has always been the fact that a service like Twitter is one small part of the larger public conversation happening across the internet. If folks do not agree with our rules and enforcement, they can simply go to another internet service."

A good idea in theory. Parler, a more recent "freedom-of-speech" oriented social media platform, was removed from Apple and Google's app stores after reports suggested it had become a refuge for Capitol Hill stormers and their sympathisers. Amazon Web Services stopped hosting it, too. Somehow, that seems like an extremely inelegant move. ■

"Banning Trump hasn't pleased everyone obviously, and even Twitter CEO Jack Dorsey was philosophical about it, wondering aloud if the platform had done the right thing."

SHAUN PRESCOTT
Author, PC Gamer editor and passionate technology observer, Shaun covers trending tech topics for *APC*.

TWO BITS

Intel all but kills off its consumer Optane product lines

I raise my glass.

A few years back, Intel's 3D Xpoint memory, aka Optane, was hyped as a game changer in the storage market. It was touted as superior to NAND SSDs in several key areas, particularly its low queue depth performance, low latency and endurance. All noteworthy characteristics, but competing against the mass produced and ever cheaper and denser NAND has proved too big a challenge. As such, Intel has pulled the pin on its consumer Optane parts, though development continues in the enterprise space where cost is less of an issue.

I have to say, that's a real shame as I was a strong believer in the tech, particularly when it was first shown. Optane had 'revolutionary' written all over it. A hybrid of flash storage and DRAM/persistent memory is a game changer. The idea that we could have PCs that can boot to Windows almost instantly, next to non-existent game load times and storage with DRAM like latencies and speeds that put the best NAND drives to shame was a laudable and exciting goal. At least it's come to fruition in the enterprise space.

Many in the tech media were critical of Optane products, some of it was justified. The easiest of all performance differentiators to understand is sequential read and write performance, something Optane never really excelled at. The strengths of Optane are harder to define. It was always the low latency and I/O performance that stood out. These are the things that make a PC feel fast and responsive.

Along the way Intel made some questionable strategic decisions. I didn't understand why Optane was marketed as a low end HDD caching technology, when you might as well just buy an SSD. Additionally, Optane support was initially restricted to Core CPUs, not Pentiums or Celerons, and also it's not enabled on the budget tier chipsets, like H310 or H410. Users with these products are more likely to run a HDD, yet cannot use Optane.

Another strange decision involves the pairing of an Optane cache with QLC NAND in the case of the H10 and H20 SSD's. It's like Intel couldn't decide if Optane was an enthusiast-tier product or an entry-level one. At the high end you'll find the 905P and that drive is an absolute performance powerhouse, but very expensive.

If Intel managed to produce a 500GB or 1TB PCIe 3.0 x4 drive with a not-too-crazy price premium, we're sure many a gamer would have happily used that as a game install drive, where you'd be enjoying stunningly fast loading times and next to non-existent level transitions. Sadly, it's not to be.

Intel says its hybrid H20 drive will continue in the laptop and OEM market, at least for now. The enterprise Optane market will continue and there are some exciting developments on the horizon with the Alder Stream generation coming. I hope Optane will make a retail comeback sometime in the future in one form or another. How about a 2TB DIMM form factor drive with a few million IOPS, latency measured in nanoseconds, 15GBps reads and writes that's also persistent, so you can turn on your PC and return to your desktop virtually instantly? Come on Intel. Show me.

I won't ask how much it will cost. ■

CHRIS SZEWCZYK
A life-long PC tech enthusiast, Chris has worked acoss the industry in many areas as a product and technology expert.

RANDOM ACCESS

Google threatens to drop Australia if it has to pay for news

Google says paying for links breaks search engines, but the ACCC says it's the only option for a healthy online media ecosystem.

There was a time, not that long ago, where people went to their favourite newspaper or media site for the latest information about the world. This meant that out of all the people that visited a website, the largest number of daily users or readers would be on the home or front pages of publications.

Advertising is primarily a numbers game. The more people you can reach, the more you can charge for ads. So it makes sense that in the days where the largest volume of people visited the home and front pages, that particular page would pull in the most revenue. At this point advertising on the front page was a major, if not the primary, source of revenue for a news organisation, but it hasn't been that way in a while.

As Google continued to refine its algorithms and improve the way it organises and sorts the web, it got better at showing you the news you wanted to see, from a wide range of publications and could amalgamate that information all in the one place. Whether intentionally or not, this process meant that Google was able to outcompete traditional news front pages with an amalgamation of every single news outlet online. As a result, traffic to home pages of media sites has dropped enormously and the whole way news is written has changed permanently.

If Google was ever asked at a US senate hearing how a free search engine makes money, Alphabet (Google's parent company) CEO Sundar Pichi might be inclined to smirk and say "we sell ads" in the same way Facebook's CEO once did. Google sells search campaigns that put promoted content at the top of search results, it sells traditional display campaigns that viewers can read or click on, it sells YouTube video ads, shopping item slots and map campaigns… and it sells all of these advertisements on the news search results it amalgamates for people get every day.

A new era of crippled journalism

If news was healthy, and media organisations were employing a solid team of staff that were capable of doing thorough investigative reporting then you might be inclined to say, good on you Google, you carved out a clever niche in a complex business – but the fact is news is suffering, journalists are a dying breed and this search-based news cycle is creating some unique issues in the democratic process and the fabric of society along the way.

According to a 2019 report by the News Media Alliance, Google made US$4.7bn in advertising revenue from news content in the US in 2018… roughly the same as the US$5.1bn total amalgamated revenue by the entire US news industry. Google News also more than doubled the unique monthly visitors of CNN and the New York Times in 2018, when it had less than half the visitors in 2009.

In Australia you're seeing this trend contribute to the hundreds of local newspapers that closed in 2020, but perhaps the most damage comes from the erosion of advertising revenues in news outlets, that in turn leads to a thinning of staff numbers to a point that hampers their ability to effectively fact check details on stories, or sub-edit copy for mistakes.

In addition to undermining the overall quality of news, the search-based discovery system has changed the types of articles that get written by pushing them towards highly searched terms and more clickbait style articles that do whatever is needed to get readers onto their website. For most these types of articles are a disappointment, but to some it is just a regular news article from another 'fake news media' group. If you can't trust journalists guided by an ethical code of conduct with

JOEL BURGESS
When not reviewing PCs for *APC* and writing our funny pages, Joel likes to ponder tech and how it's used.

official oversight and reputations that can be tarnished, then who can you trust to give you unbiased, factually accurate information?

The price of freedom

Google also tailors the news it shows you to display things you are more likely to want to see, based on your previous article choices. While this might be great in a social media setting, and users will probably enjoy flicking through their news feed more, it leads many people to only see the news that they want to see. In extreme cases this can push users down more partisan pathways where their worldview is reinforced to a point that they become even more set in their social and political views. Popularity-focused news is shifting people in ways that were less common when people read a curated set of stories, prioritised by a balance of popularity and perceived importance, by someone who has a good grasp of the story's context.

YouTube's tendency to push users to more extreme or intense examples of subject matter to keep them on the platform longer is well documented, but there is a real risk that customised news feeds are creating a divide amongst people as well. This kind of bias existed well before Google, and the allegiances of major media organisations continues to affect the stories presented by many publications to this day. It is by no means a perfect system, and you only have to read the front page of various publications on any given day to see just how much business and political allegiances impact the information you see, but this system doesn't change when you use Google News, it simply adds another layer to the equation.

The Australian Competition and Consumer Commission (ACCC) has been working on a News Media Bargaining Code since April 2020 with an initial draft released in July. The preliminary legislation outlined the proposed rules of engagement for Google and Facebook in regard to handling news content in Australia. In August 2020 Google submitted its response to the proposed legislation, citing issues with the code's requirement to notify news orginasitions ahead of any algorithmic changes that would affect news search rankings, the legislation's supposed undervaluing of benefits already provided to news organisations and the concern that a news organisation would be able to extract more revenue from Google than its stories generated independently. The submission also noted that if the legislation was not amended Google would either be forced to avoid updating its search engine in Australia, or abandon search locally altogether. Google Australia's Managing Director, Mel Silva, reiterated this message in front of the Senate Economics Legislation Committee in January 2021 stating that the current code was unworkable and "if this version of the Code were to become law it would give us no real choice but to stop making Google Search available in Australia."

The main point of contention for Google is having to pay to link to content by registered news businesses, which Silva suggests would "set an untenable precedent for our business". It is true, there is no other example on the internet of a business paying to provide traffic to a source, but when you balance how many people visit Google to find news that is researched, written and published by third party organisations, is seems surprising for Google to be taking the lion's share of advertising dollars that an article is capable of creating. Especially when the extracted resources mean that it's having a direct impact on the quality of journalism that is able to exist.

"In addition to undermining the overall quality of news, the search-based discovery system has changed the types of articles that get written by pushing them towards highly searched terms and more clickbait style articles that do whatever is needed to get readers onto their website."

Only Google can't lose

While traditionally the quality of news research had a direct impact on that publication's sales, and could be rectified by prudent business decisions, for Google there are no immediate repercussions for the level of journalism dropping. People aren't just going to give up looking at news because they read a dud article. Even if there was no news left, Google would still be able to make money from your searches for it, so there is little incentive to promote the industry.

That being said, Google has proposed addressing some of its less expensive issues, like news bias, and has offered to pay publishers for access to content that would usually be behind a paywall under a proposed scheme called News Showcase. Google's proposition of contracting publishers for news content curation is really something to help Google News be less biased, and a better media product. Paying for paywalled stories is a more complicated proposition. Initially it'd just erode one of the few revenue streams available to news publications, but theoretically it could work long-term, if every news publication had every one of its articles paywalled.

There are a couple of problems here though, the first is that Google has a global budget of $1.3 billion to use over three years on this News Showcase scheme. This figure is about a quarter of its news search related revenue in the US every year, so it probably wouldn't be a big enough budget to compensate just Australia's news media adequately in that timeframe. The other issue is that many publications have a mainly ad-based revenue business model that wouldn't benefit from swapping to a paywalled offering overall anyway.

Google has other arguments about how it provides services and value to the Australian market which should be considered in the equation, and there's no doubting that this is valid, but it might be time we understood the fact that Google was only able to make transformative products like the free GSuite apps from money it siphoned from the media industry.

Don't get me wrong, I'd way rather give my money to Google than plenty of Australian media companies... but if we want proper investigative journalism to thrive in Australia, we might have to get used to the idea of going back to paid non-Google work tools like Microsoft's Word... and even consider the possibility of using Bing ■

Cyberpunk 2077

Time for an upgrade

The most anticipated game for years, *Cyberpunk 2077,* provides insight into all the modern complexities of game development. Hundreds of individuals worked for years to bring Night City to life, and while I appreciate much of the end result – despite the bugs and glitches – it's clear developer and publisher CD Projekt Red made serious mistakes.

The company admitted as much, and in an unprecedented move, the game was pulled from the PlayStation store, and everyone who purchased it was offered a full refund. Microsoft likewise offered full refunds for Xbox One players. The PC release running on modern hardware still has some issues, but nothing so far that I've considered fully showstopping. Maybe I got lucky, but more likely is the fact that I'm drastically exceeding the official minimum recommended specs.

CD Projekt Red lists a relatively ancient Core i5-3570K or FX-8310 CPU, 8GB RAM, and a GTX 780 with 3GB of VRAM as the minimum hardware requirements. You'll really want a newer GPU, and the GTX 1080 barely breaks 60fps at 1080p medium. Along with a decent graphics card, though, you'll want a better CPU as well. The i5-3570K is a four-core/four-thread Ivy Bridge CPU, never mind the AMD Bulldozer chips that never quite lived up to expectations. Bottom line: Things are going to be much worse trying to run a complex game like *Cyberpunk 2077* on old hardware.

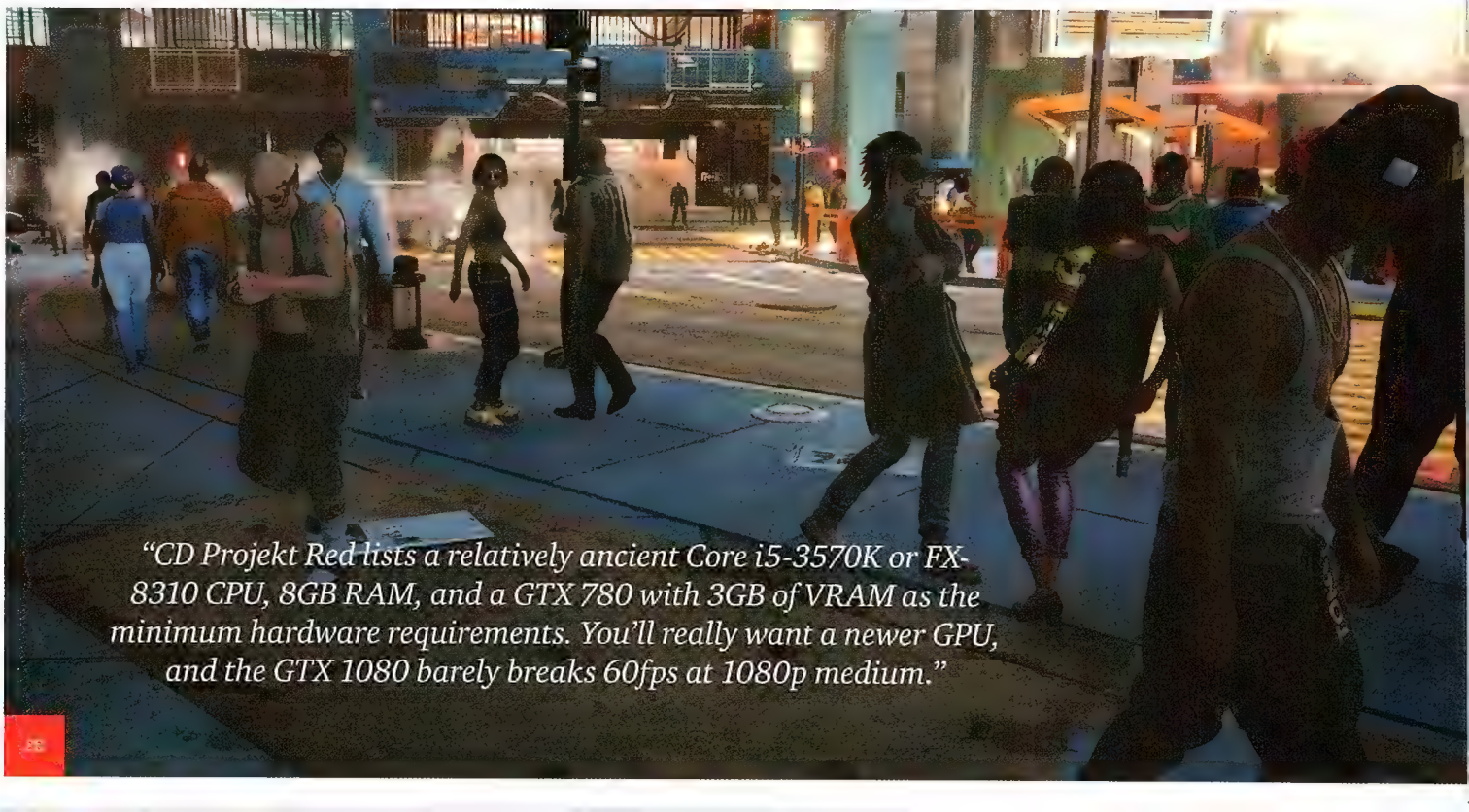
Night City is a sprawling metropolis, and you can drive from one end to the other without a single loading screen. Scaling that down to run on CPUs that launched over eight years ago is a recipe for disaster, but things really went wrong with the previous-gen consoles. CD Projekt Red knew the game had problems on the Xbox One and PlayStation 4, but the holiday season was calling. However, it wasn't ready, and I'm not sure it's ever going to be a good experience on those consoles.

AMD's Jaguar cores sit at the heart of the Xbox One and PS4. Jaguar was already slow even when it was new. It was designed to be a power-efficient architecture, with speed very much a secondary concern. Each Jaguar core is relatively simple, dispatching up to two instructions per clock. Third-gen Intel cores, in contrast, can do four instructions per core. Add in larger caches, better branch prediction and other elements, and basically Ivy Bridge is at least twice as fast as Jaguar at the same clocks. Even the updated Xbox One X and PlayStation 4 Pro only clock in the low 2.1-2.3GHz range. Third-gen Intel CPUs run at 3.0-3.9GHz, while modern AMD and Intel chips can hit 5GHz, dispatch up to six IPC per core, and have six to 16 cores.

While the previous-gen consoles have OK GPUs (basically RX 570 level), the eight Jaguar cores are a major bottleneck in *Cyberpunk*. Core i9-9900K is easily five times as fast as the console Jaguar CPUs, sometimes more. Which already sounds bad, and then you realise that the i9-9900K ends up limiting performance in *Cyberpunk 2077* to around 110fps. 20 percent of that? Yes, we're looking at fps in the low 20s, or worse. The PlayStation 5 and Xbox Series X are also eight-core/16-thread CPUs, and that was clearly a target for the game.

It's going to be interesting how things progress. CDPR is working hard on fixing performance and bugs for both PCs and consoles. Will that eventually make for a playable 30fps experience on the PS4 and Xbox One? Possibly. ■

JARRED WALTON
Jarred Walton has been a PC and gaming enthusiast for over 30 years.

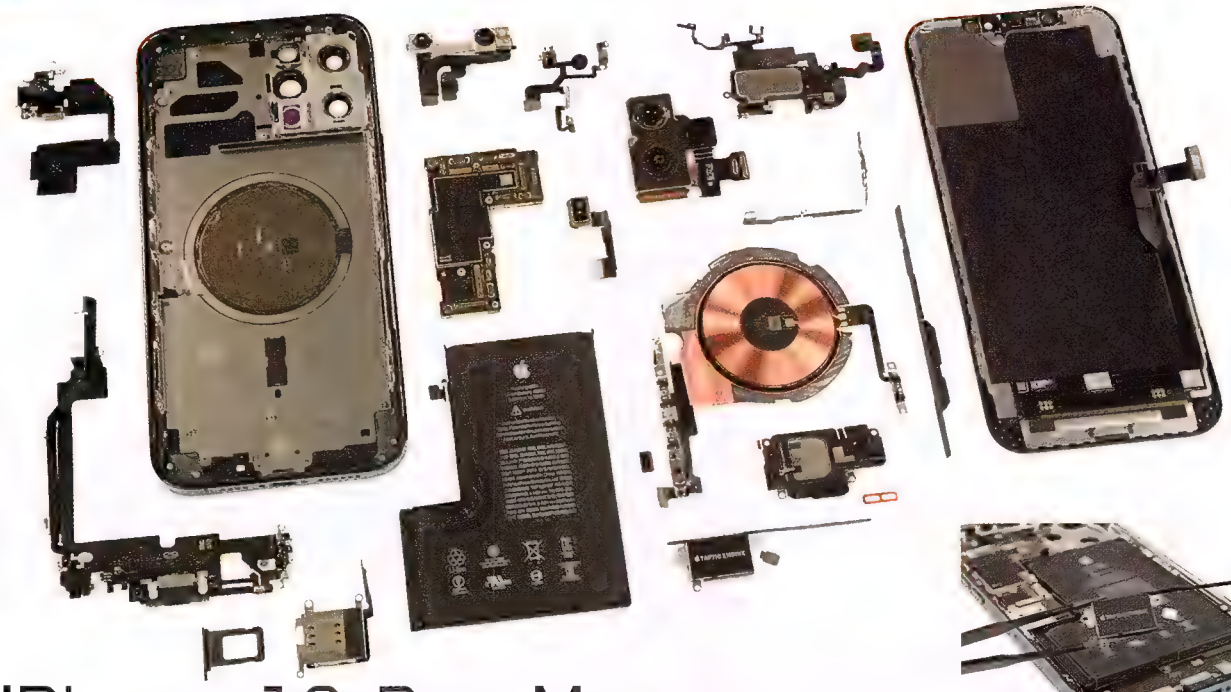


Turning Night City into a thriving metropolis requires a powerful CPU.

"CD Projekt Red lists a relatively ancient Core i5-3570K or FX-8310 CPU, 8GB RAM, and a GTX 780 with 3GB of VRAM as the minimum hardware requirements. You'll really want a newer GPU, and the GTX 1080 barely breaks 60fps at 1080p medium."

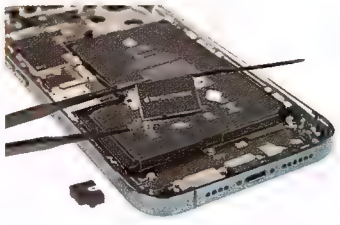
HOW IT'S DONE

TAKING THINGS APART AND HAVING A POKE AROUND



iPhone 12 Pro Max

The name might not be all that different from the last gen, but everything else is.



The haptic user feedback engine, the "taptic," comes in its own little metal caddy.

We've torn down the mini iPhone and the two medium iPhones, but we saved the biggest for last: the iPhone 12 Pro Max. Time to give this full-bodied phone the full teardown treatment.

MAJOR TECH SPECS

- A14 Bionic SoC with fourth-generation Neural Engine
- 6.7 inch (2778x284 pixels) Super Retina XDR OLED display with P3 wide colour gamut and True Tone
- 12MP triple camera with wide angle f/1.6 (OIS), ultra-wide angle f/2.4, and telephoto f/2.2 (OIS) cameras, with a LiDAR module
- 6GB RAM, 128GB storage (256 and 512GB configs available)
- 5G (sub-6GHz and mmWave), plus 4x4 MIMO LTE, 802.11ax Wi-Fi 6, ultra-wide band (UWB), NFC, and Bluetooth 5.0
- MagSafe 15W wireless charging
- P68 rating, water resistant to a maximum depth of 6 meters for up to 30 minutes under IEC standard 60529

KEY FINDINGS

- Sorry to break it to you, but size does matter – at least when it comes to camera sensors. To achieve its alleged 87 percent improvement in low-light performance, the 12 Pro Max uses the biggest sensor in an iPhone yet.
- A standard-issue heat and iSclack application persuades this big Pro Max to let its guard down and share some secrets. We head for the headline Pro Max feature: the new cameras. The standard wide camera (bottom-left in the group of three) is the source of all the 12 Pro Max chatter. It reportedly houses a 47 percent larger sensor, allowing it to gather more light and, thus, take better photos. With X-ray vision, we see that the standard wide's sensor is definitely bigger. We can also clearly see the four magnets surrounding it – telltale signs of Apple's brand-new sensor-shift image stabilisation system.
- The iPhone 12 Pro Max's primary (wide-angle) sensor is big. Not unlike the phone it lives in. We're skeptical when a "Pro" feature only makes it into a larger, more expensive model, but there's a decent chance this sensor wouldn't fit in the cramped corner of the smaller iPhone 12 Pro without compromises. It dwarfs the iPhone 12's sensor. It's 47 percent larger but is the same 12MP, so each pixel is larger and captures more light.
- The Max has the winning battery out of all the iPhones 12, not just in power, but in technology. X-ray vision shows that the Max's battery pack isn't quite full to the brim, but it's darn close – and the high-tech shape allows it to turn the corner on capacity. The Max power source weighs in at 14.13Wh, tipping the scales against the 8.57Wh mini battery and the 10.78Wh 12 and 12 Pro. It's a slight step down from the 15.04Wh pack in the iPhone 11 Pro Max, and it definitely falls behind the Galaxy Note 20 and 20 Ultra (16.69Wh and 17.46Wh respectively).
- With the Pro Max's logic board extracted, we're tempted to say it might be even more compact than that of the iPhone 12 mini; but the mini's integrated SIM reader leaves it at a disadvantage. The 12 Pro Max had a detached, modular SIM reader, as in the 12 and 12 Pro – which is also a bit more repair-friendly.
- Repairability Score: 6 out of 10 (10 is easiest to repair). Screen and battery are reasonably accessible for replacement. Most components are modular and replaceable. Some uncommon screws complicate all repairs, but reusable fasteners are preferred over adhesives. Waterproofing helps reduce the frequency of some repairs while complicating others. The glass back makes drops even more dangerous and requires a full case replacement if it breaks. ■

The basics of this iPhone look about the same as the rest of the 12 family, but the dark steel frame is Pro-only.

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GADGETS

TECHY TOYS THAT MAY OR MAY NOT INSPIRE JOY

AU$399 | blueant.com.au

BlueAnt X5 Bluetooth Party Speaker

A portable and affordable party machine.

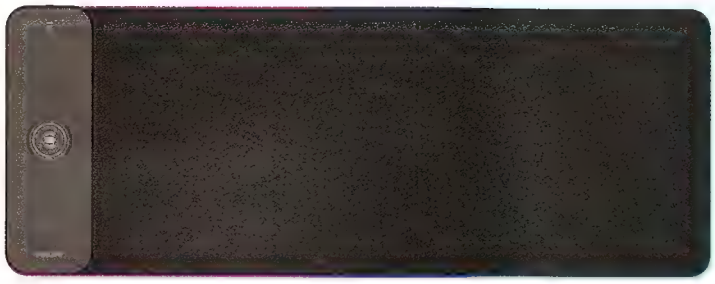
While it may not be the most timely release given the global pandemic and frequent lockdowns, the BlueAnt X5 is still a party speaker worth celebrating. The largest and most powerful speaker in the company's recent 'X' lineup, it offers 60 watts of loud, bassy audio, a flashy light show, and even packs a pair of microphones in the box for the karaoke fiend among us. While it's a mono speaker (you can pair two of them for stereo if you want), the audio sounds great and can get seriously loud. It's also battery powered, promising up to 20 hours of playtime at 50 percent volume, and when you pair this with its neat carry handle and a weight of just over 4kg, it's one of the most portable solutions of its size and power we've come across.

AU$74 | brookaccessory.com

Brook Power Bay Switch dock

A well-priced Switch problem-solver.

The Nintendo Switch isn't perfect. Aside from the widely reported stick drift that plagues its detachable Joy-Cons, the dock itself is a little lightweight. Some players have reported that lifting the console in and out of the dock can lead to marks on the screen. That can be avoided if you're careful, but if you've got young kids or shaky hands, it can be a problem. Not to mention the fact that a first-party dock replacement is expensive at AU$129. This third-party Brook Power dock is not only markedly cheaper, but it's also more portable, supports Bluetooth pairing with headsets, and comes with two Gamecube controller ports for dedicated *Smash Bros* purists. It's not a pretty thing, looking like something from the Nintendo 64 era, but it's a functional replacement, and we've used it for four months consistently without it damaging our console. A new model set for release in April will add an Ethernet port, too.



AU$84 | www.maro.com.au

Philips SPL7604 Wireless Fast Charging RGB Mouse Pad

Have more things that glow.

Looking to replace your mouse pad with something a little fancier? Larger? And with a built-in phone charger? Want something a bit extra that also matches your colourful RGB keyboard and mouse? Consider, then, the Philips SPL760 – a large keyboard and mouse pad that also doubles as a Qi phone charger with a colourful RGB outer edge. Not only is it large enough to fit your keyboard and mouse, it also has the extra space to rest your wrists. Colours are easily changed from cycling rainbow to solid with the press of a button – so no software is needed, as it should be. All-in-all, a great product that delivers as promised without the fuss of needing an app to make it work.

$TBC | razer.com/concepts/razer-project-hazel

Razer Project Hazel

An RGB ventilator mask for gamers that won't let an apocalypse get in the way of style.

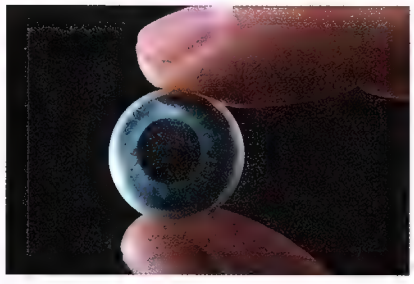
While you might think that your gaming station is the safest place in this pandemic ridden world right now, Razer reckons it's not... at least not yet. Project Hazel, the inexplicable codename for Razer's new high tech N95 mask, walked the catwalk for the first time at the Virtual CES this year. Razer likes to call it 'The world's smartest mask', which is a pretty low bar when you consider most masks are made of cotton, but active ventilation, an N95 filtering spec, transparent LED-lit mouth visor and UV sterilisation case make it seem actually somewhat useful. It even comes with a microphone to enhance your Darth Vader impersonations.

$2,049 | shop.samsung.com/au

Samsung The Sero Smart TV

Samsung is putting a new kind of spin on its TVs.

Millennials are watching a lot of Tik Tok these days. There's even a reimagination of *Romeo and Juliet* told through texts, Instagram videos and FaceTime calls supposedly airing at Sundance this year, so it makes sense that someone made a TV to watch all that vertical smartphone proportioned content. How? Well Samsung's The Sero TV features a rotating screen that'll spin vertically to let you watch fullscreen 9 by 16 videos from the couch. We kind of wish it had a webcam for direct video conferencing, but you can screen share from your phone while on a video call, which is almost the same thing.



$TBC | mojo.vision

Mojo Vision AR Contact Lenses

Turn your eyes into screens.

Having AR without needing to wear glasses is the stuff of sci-fi novels... unless you're following the Silicon Valley startup Mojo Vision. The team partnered with Japanese contact lens manufacturer Menicon to make a prototype smart contact lens with a tiny built in display that sits on your eyeball. It's still in the prototyping phase of development so don't expect it to hit the market before Apple's AR glasses, but with US$159 million in seed funding and 100 full time employees, if anyone's going to get AR contact lenses off the ground in the next five years it's these guys. ■

REVIEWS

THE HOTTEST GEAR LABS TESTED

$5,999 | gigabyte.com

Gigabyte Aero 17 HDR YC

Nvidia's 30 series cards arrive on gaming laptops, but there's a long list of caveats attached to these monster GPUs.

Gigabyte once kept its Aorus branding for its most elite gaming devices, but that hasn't been the case for a couple of years and the Aero 17 HDR YC is a clear example of this. This $5,999 non-Aorus machine is as top of the line as they come, featuring a Nvidia RTX 3080 Max-Q GPU and a 10th Gen Core i9 CPU from Intel.

We were pretty surprised to see an RTX 3080 in a laptop, not just because it's the first 30 series I've had my hands on, but also because of the sheer incomprehensibility of being able to fit a generally 1.5kg desktop GPU in a 2.5kg laptop. Of course the Aero 17 HDR YC doesn't have a full desktop graphics card in it, since the Max-Q 3080 pulls a maximum of 105 Watts on this device, around a third the desktop card's max power draw.

Nvidia's laptop cards are a little more complicated than usual this year, avoiding clear Max-Q branding on 30 series laptop GPUs and having variable maximum power draws of between 80 and 150+Watts depending on the vendor. It's also allowing maximum boost clock speeds to range between 1,245 and 1,710MHz on its RTX 3080 laptop GPUs, which is a big enough variability to yield very different results when gaming... so don't expect to be able to simply look at a spec sheet and know how a laptop will perform in 2021.

The Aero 17 HDR YC's RTX 3080 Max-Q GPU is supported by an Intel Core i910980HK CPU and an impressively compact cooling architecture that manages to fit into a foldable, 2.1cm-thick laptop. Sadly this compact cooling array can only do so much and Gigabyte decided to opt for the lowest boost clock of 1,245MHz. If you're planning on using the Aero 17 HDR YC for 1080p gaming, it's not really worth the investment. The Aero 17HDR YC netted fps results 28% slower than a 2080 Super in an Alienware Area 51m R2 in *The Division 2* Full-HD-Ultra benchmarks and was around 12 percent behind in *Total War Saga: Troy* and *F1 2020* using the same settings.

The Aero 17 HDR YC does however come with a VESA 400 certified HDR screen that runs at a 4K resolution, and if you dial up to this resolution you can play titles like *Metro: Exodus* at 4K Ultra using ray tracing and DLSS for stable 30 fps+ frame rates. This 17.3-inch display comes with full Adobe RGB compatibility, so you can use it for professional colour grading and the 64GB of RAM, octa-core CPU and massive Cuda core GPU allocation means it'll be a suitable workstation for any processor-heavy workflow.

While Gigabyte advertises an all day battery life, like most gaming laptops, the 99Wh battery will get between 3-4 hours when in use. The unit comes with a generous array of ports so you won't need to fork out for a dock (which is nice) and the two 1TB PCIe SSDs provide a generous amount of ultra-fast local storage.

JOEL BURGESS

SPECS
Windows 10 Pro 64-bit, 17.3-inch VESA 400 Adobe RGB LCD Display @ 3840x2160 pixel resolution; Intel Core i9-10980HK CPU; Nvidia RTX 3080 Max-Q (105W, 1245MHz boost); 64GB RAM; 2 x 1TB PCIe SSD; 99Wh Li-I battery (4h8min 1080p movie playback); 396x270x21.4mm; 2.5kg.

Best result
On test

	Gigabyte Aero 17 HDR YC	Alienware Area 51m R2	MSI GS66
PCMark 10 - Overall (score)	5,715	6,989	6,702
Max CPU Temperature (°C)	94	100	DNT
1080p movie playback (HH:MM)	04:08	02:04	03:15
HWBot x265 - 1080p (Avg fps)	44.552	57.524	50.072
3DMark Time Spy (score)	9,518	10,829	7,843
The Division 2 - 1080p Ultra (fps Av.)	85	109	DNT
CrystalDiskMark Read (MB/s)	3,404	3,536	3,433
CrystalDiskMark Write (MB/s)	3,035	2,978	2,376

A powerful gaming workstation that reins in performance and swaps it for portability.

★★★★☆

$1,700 | hp.com

HP EliteOne 800 G5

All for one and one for all.

HP's new AIO, the EliteOne 800 G5, is all business. Costing $1,700 (for our review SKU specifically), this is a professional machine, well-suited to a home office environment. The brushed silver finish is unobtrusive, and the 23.8-inch monitor has a pleasingly small bezel. Being an AIO system, it has a small footprint, with just a weighted metal rectangle as its base, upon which the rotating monitor arm and the screen itself are mounted.

It has to be said that the EliteOne is remarkably easy to set up. It's truly a plug-and-play affair, with the entire assembly slotting together without any tools required, and only a single three-pin kettle cable needed to power it all up. Included in the box is a wireless Bluetooth "Business Slim" mouse and keyboard combo from HP, which connect instantly with the touch of a button once their shared USB dongle is plugged in at the rear of the display. It's a nice inclusion that makes setup a breeze, but it should be noted that the mouse and keyboard are older models and do feel a bit unimpressive nowadays.

Once you've got your speedy setup out of the way, you'll be able to enjoy the EliteOne's bright and colourful display. It's a 1080p WLED-backlit panel, large enough for work or entertainment, and the EliteOne also comes with a pricier touchscreen variant for those who prefer a more tactile display. We weren't blown away by the screen, but it's certainly a good choice of display – better than the 17-inch FHD panels found on the many home office laptops.

In broader performance terms, the Intel Core i5-9500 processor in this AIO struggles in some areas, while excelling in others. Single-core tasks are a breeze, but multi-core workloads don't fare quite as well. With only 8GB of RAM and no discrete GPU, HD gaming and other 3D-rendering tasks are pretty much out of the question. For your standard office work, though, it manages just fine, keeping numerous Chrome tabs or spreadsheet columns up and running with ease. It does all this quietly, too, with barely any fan noise even under duress. The rear panel where the CPU is housed got a little warm during some of our benchmarks, but never for long.

SPECS
Intel Core i5-9500; UHD Graphics 630; 8GB DDR4 2666MHz; 23.8-inch IPS WLED-backlit 1080p widescreen; 256GB M.2 NVMe SSD; 1x HDMI, 1x DisplayPort 1.2, 4x USB 3.1 Gen2 Type-A, 1x RJ-45 headphone jack; Wi-Fi 6, Bluetooth 5; Slim Blu-ray/DVD/DVD-ROM writer double layer.

A high-speed M.2 SSD makes file transfers and load times nice and fast, with read speeds approaching 3.5GB/s. Our model had a 256GB drive, which might be enough for some, but we'd advise opting for the 512GB or 1TB variants. Both the drive and memory are consumer-upgradable, but it's more of a hassle to do so than with a typical laptop.

Overall, we do have to ask if this AIO is really any better than having a laptop set up for working at home. Yes, the pop-out disc drive and webcam are cool, but these features can be found on laptops. The main advantage here is the quiet running and the bigger, brighter screen, since the EliteOne's performance figures certainly won't trouble any laptops around the $1,700 price point. Ultimately, while the EliteOne isn't terrible, you could pick up a more powerful and portable machine without making such a big dent in your wallet.

CHRISTIAN GUYTON

Quick and easy setup and quiet running, but just a bit too expensive

★★★½☆

Indicates best result

	HP EliteOne 800 G5	Zero Point
Cinebench R15 Multi (Index)	979	541
CrystalDisk QD32 Sequential Read (MB/s)	3,455	540
CrystalDisk QD32 Sequential Write (MB/s)	1,414	372
3DMark: Fire Strike Ultra (Index)	[illegible]	183
Rise of the Tomb Raider (fps)	[illegible]	5
Total War: Warhammer II (fps)	[illegible]	3
Tom Clancy's Ghost Recon: Wildlands (fps)	[illegible]	2

Our zero-point consists of an Intel Core i3-8100, 8GB of Team Vulcan DDR4 @ 2400, and a 120GB Kingston SSDNow UV400. All tests were performed at 1080p at the highest graphical profile.

$1,199 | www.benq.com

BenQ EW3280U

A 'premium' entertainment-oriented monitor from BenQ. But does the claim stand scrutiny?

A few months ago, BenQ impressed us with its funky-looking Mobiuz gaming monitor that offered decent performance and features at an incredible price. The EW3280U is from BenQ's 'Entertainment' range and comes at a price that's double its rivals. So, what are the differences and are they worth the money?

Our first impressions were generally positive. The colourful design accents of the Mobiuz have been replaced with sober-yet-classy, metallic-brown styling. There's a thin bezel but it's extended by a 5mm black deadzone around the top and sides of the display meaning it doesn't lend itself to the tiling of multiple monitors. Nonetheless, the 32-inch screen still provides plenty of real estate.

Beneath the screen is an integrated speaker bar that has a built-in subwoofer and supports 2.1 audio with 'treVolo' technology. BenQ claims it uses, "Customised speakers, internal 2.1 channel sound [and] multi-point suspension to eliminate vibrations." You can also use audio presets to optimise for Cinema, Pop/Live, Rock/Party, Dialog/Vocal and Gaming. In many regards it succeeds – the speakers get loud and punchy, with some impressive bass, while maintaining fidelity for vocals. However, when we played Björk's *Play Dead* at high volume, the unit rattled and vibrated due to the powerful treble. They can't compete with regular computer speakers, but they're still impressive for an integrated unit.

The screen has a UHD 3,840 x 2,160 resolution and uses IPS technology. It displays an impressive, crystal clear desktop that's great for office work (especially spreadsheets) and has a matte coating that eliminates reflections.

It impressed us when playing-back high-quality UHD content: it's colour reproduction is excellent, there's minimal light bleed and halo effects (despite a singular LED backlighting system) and contrast is impressive with near-true blacks capable of being displayed. The panel supports HDR10 but SDR content can be tinkered with using BenQ's HDRi emulation technology which (among other things) uses a built-in light sensor to optimise contrast performance according to ambient light and the task you're performing. In reality, the resulting adjustments come down to personal preference.

SPECS
32-inch, matte; 3,840 x 2,160; flat-screen; 60Hz LCD with IPS panel; 5ms G2G response time; 400 nit brightness; 1000:1 contrast; FreeSync; HDRi; 95% P3 gamut; HDR10, VESA DisplayHDR 400; DisplayPort 1.4; USB-C display with PD; 2 x HDMI 2.0, 3.5mm audio jack; 2 x 2W speakers; 5W woofer; Tilt -5o/+15o; No swivel, rotate or height adjustment; IR Remote

An impressive technology is BenQ's eye-care. The abilities to filter Blue and Red light to minimise eye fatigue are extensive and spread across manual incremental adjustments, selecting pre-programed settings and automatic, dynamic adjustments based on the sensor.

Beyond that, the usual ports are catered for, although we were impressed to see that a USB-C display input was included too.

So far, so good but there are three significant issues. Firstly, the panel is only capable of a 60Hz refresh rate at maximum resolution: experienced gamers will notice the lack of smoothness in fast-and-frantic sessions. Secondly, at $1,299, it's double the cost of 4K, 32-inch, IPS rivals. This, combined with the fact it's been available globally for 11 months already, makes us question the premium price tag and seriously dents the value proposition of what otherwise is a very good entertainment monitor.

NICK ROSS

An attractive monitor but it costs too much.

★★★★☆

$2,249 | dell.com

Alienware AW3821DW

All of the bells and whistles.

Here's a premium gaming screen that packs in every important new and high-end technology. Its versatility extends beyond gaming, thanks to the crisp 3840 x 1600 resolution – with the relatively rare in an ultrawide 1600 vertical res making all the difference to small text readability, and the amount of area you have to work (and play!) with.

It's similar in spec to the Acer Predator X38 we reviewed back in *APC 484* (September 2020), which is also selling for around the same price, and, if it's not using the same panel, it sure is extremely close in its performance.

The screen is able to run at very high brightness, and for most of the testing I did over a two month period I didn't need to raise it higher than 50%. That gives you the scope to find the right setting regardless of ambient lighting. The panel has a little bit of backlighting leakage in the corners when brightness is at the higher end of the scale, but it's only visible when the screen is dark, so in practise when gaming brightness is likely to be lower so you won't see the issue, and for working on a white document or sheet the lighting and colours are uniform and no bleed is visible.

The relatively gentle 2300R curve is barely noticeable. I personally think ultrawides should have a generous curve. The whole idea, after all, is to reduce the amount of refocussing your eyes need to do as they pan from edge to edge. On the plus side, Alienware's new stand is absolutely excellent, and won't dictate where your mouse pad needs to be to avoid the feet, which are nice and flat and as far back as they could be without it tipping over. Adjustability covers tilt, swivel and a small amount of rotate just in case things aren't level. Presentation overall is superb. The slick white colour and non-shouty RGB lighting give it a mean-yet-classy look.

This is a G-Sync Ultimate screen, so HDR is part of that spec, but at HDR 600 it's only just getting into the zone where HDR effects in games are impressive. 600 is the bare minimum, but at least it's enough to make the effect pop in games where it's well implemented. It'll run at 144Hz via its DP 1.4 connection, which is plenty enough considering the resolution your graphics card has to push. Using an RTX 3080 in testing, around 80-150fps in AAA games is typical at this resolution, so it's a good balance. Oddly, the same HDMI to Lightning cable I use for connecting monitors to my Mac refused to work with this, but that's not exactly a common configuration. In the end it worked via an Elgato HDMI to Lightning dock.

For gamers it's a luxurious beast. The big-res combined with ultrawide size ensures fine and crisp detail and mesmerising immersion, and with up to (down to) 1ms response along with the G-Sync Ultimate benefits, gaming with be beautifully fluid. Though $2,500 isn't to be sneezed at, at this end of town the massive resolution brings genuine wins to regular work and casual use.

BEN MANSILL

SPECS

38inch, matte, 3840 x 1600 21:9 @ 144Hz, 2300R curve; 1000 to 1 contrast; 1ms (extreme mode); Nvidia G-Sync Ultimate, VESA DisplayHDR 600; 95% DCI-P3; DP 1.4, 2 x HDMI 2.0, 3 x USB 3.2 Gen1; tilt: -5° to 21°, swivel: -20° to 20°.

Huge, high spec and able to deliver supreme satisfaction for both gaming and work use.

★★★★½

apc HOT PRODUCT

$199 | www.samsung.com.au

Samsung 870 Evo 1TB SATA SSD

Samsung again reminds us why it's a leader in the SSD market.

Even though SATA is secondary to NVMe in terms of performance these days, SATA is here to stay for some time yet. Samsung SSDs of both types are almost always on buyers' shortlists. It's been three years since the release of the 860 Evo and Pro, and with the continual advances in NAND and process tech, Samsung is taking the opportunity to refresh its line up and in doing so, has the opportunity to redefine the SATA SSD market once more.

The 1TB Samsung 870 Evo we have in for review is a standard form factor 2.5in SATA 6GB/s SSD. It makes use of Samsung's 128 layer TLC V-NAND which is combined with 1GB of LPDDR4 memory. Samsung is using its MKX Metis controller, likely with some under the hood updates over the version found in the 870 QVO series. The endurance rating of the 870 Evo is an impressive 600 TBW for the 1TB model. This compares to 360 TBW for the 870 QVO. It remains the case, if reliability under heavy loads is paramount to you, QLC remains inferior to TLC.

The 870 Evo features Samsung's TurboWrite technology, where a portion of the TLC NAND is provisioned as SLC. With up to 42GB for the 1TB model, this allows for much faster sustained write operations. You also get features such as TRIM, garbage collection and SMART monitoring. There's 256-bit AES encryption with TCG Opal 2.0 compliance. Throw in a five year warranty and the class-leading Samsung Magician software that includes over-provisioning, secure erase and monitoring functionality and the 870 Evo ticks all the boxes.

Features and technologies don't mean much if it doesn't perform,

SPECS
Samsung MKX Metis Controller; Samsung 128L TLC NAND; 560MB/s sustained read; 530MB/s sustained write; 98K/88K Read/Write IOPS; 600TBW endurance, five year warranty.

but that's not a worry. The 870 Evo's QD1 read performance is the best we've ever seen from a SATA drive. The 870 Evo beats out the 860 Evo and manages to pull ahead of the 860 Pro in many tests while costing a lot less. The new 870 Pro has its work cut out if it's to offer any significant advantage.

The Samsung 870 series could be one of the last performance oriented SSD series before the QLC and even PLC (quad and penta layer cell) drives begin to overtake higher capacity HDD's in cost per gigabyte. We're not there yet though. A quality SATA drive like the 870 Evo is still perfectly viable as a boot drive in a laptop or as a secondary game drive. NVMe drives are the undisputed performance leaders but not everyone has slots or lanes available to add more drives. We're many years from calling the death of SATA.

The Samsung 870 Evo is our new favourite SATA SSD. It ticks all the boxes. It's fast, reliable and it has a strong feature set. About the only real weakness is the pricing, and for that reason we can't give it a perfect score. That's certain to fall over the lifetime of the drive though. Until we test the Pro model, the Samsung 870 Evo is the best performing SATA SSD on the market. Whether you want one to run your OS, use it as a game storage drive or as an upgrade for a SATA based laptop, you can't go wrong.

CHRIS SZEWCZYK

Our new favourite SATA SSD.

★★★★½

Indicates best result

	Hontek 960GB	Samsung 870 Evo 1TB
Crystal Disk Mark Sequential Read (MB/s)	559	561
Crystal Disk Mark Sequential Write (MB/s)	490	530
Anvil Storage Utilities 4K Random Read (MB/s) Queue Depth 1	23.02	44.14
Anvil Storage Utilities 4K Random Read (MB/s) Queue Depth 4	17.36	35.52
Anvil Storage Utilities 4K Random Write (MB/s) Queue Depth 1	94.43	102.75
Anvil Storage Utilities 4K Random Write (MB/s) Queue Depth 4	58.74	79.68
Anvil Storage Utilities 4K Random Read (IOPS) Queue Depth 1	5,996	11,240
Anvil Storage Utilities 4K Random Read (IOPS) Queue Depth 4	17,770	39,871
Anvil Storage Utilities 4K Random Write (IOPS) Queue Depth 1	24,081	26,462
Anvil Storage Utilities 4K Random Write (IOPS) Queue Depth 4	60,846	81,593

$144 | www.hontek.com.br

Hontek 960 GB SATA SSD

SSDs reach commodity status.

Now here's a product that you are unlikely to have come across before. A Hontek SSD! Before you roll your eyes, consider that SATA SSDs are pretty much commodity items nowadays. A cheap SSD should perform much the same as another. Hontek might not be a household name, but if it does the job, should you consider it?

Hontek is a Brazilian company that resells OEM drives under its own label. The 960GB version we have here for review is a standard 2.5in SATA 6GB/s drive. It's rated for 560 MB/s read speeds and 510 MB/s writes, ratings that are common to even the cheapest SSD's these days. It makes use of SpecTek NAND, which is a division of Micron. The controller is a Silicon Motion SMI2259XT. Micron and SM are well known brands, so even if Hontek is not, its parts are, though they are not the latest and greatest by any means. At least you get features like SMART and Trim but there isn't any encryption or software that we could find to download. The warranty runs for three years but again, we couldn't find any information about its endurance rating. This is a plug and play set and forget drive, though only because you have no choice! There's an optional USB 3.1 external enclosure if you really want to use it in that way.

All in all, this is a very basic drive that faces stiff price competition from well-known brands. Can it make up for it with a decent performance showing? The sequential performance numbers all but max out the 6GB/s connection, and its copy and write performance isn't all that bad. Random read and IOPS performance is a definitely its weak point and this is a problem as it's what makes a drive fast and responsive.

If cheaper drives have better read performance and a better price, is there a reason to buy this drive? We have to say no, there isn't. That's probably being a bit too harsh though, as if this drive was $10 or $20 cheaper, we could make the case that it would make a decent upgrade for a five or so year old cheapie laptop that's bogged down by a HDD. All thing considered, it's an unremarkable basic budget SATA SSD that struggles to compete in a highly competitive market. There's no reinventing of the wheel here. It's not really a bad product so to speak and a casual user would hardly recognise the difference between this and a faster NVMe drive.

Many users will look at the name of the drive and instantly rule out buying it. To offset this, a drive like this needs to deliver on value. Sadly it doesn't as there are several brand name 1TB SATA drives available for less. The much faster NVMe Crucial P1 can also be found around the $140 mark. Given that SATA drives have reached a performance plateau and value 1TB models are all priced within a few dollars of each other, without a clear value advantage to offset the unknown branding, the Hontek 960GB is a tough sell at best.

CHRIS SZEWCZYK

"If cheaper drives have better read performance and a better price, is there a reason to buy this drive? We have to say no, there isn't."

SPECS
Hontek 960GB 2.5in SATA 6GB/s SSD; Silicon Motion SMI2259XT Controller; Spectek N18A NAND; 560MB/s sustained read; 510MB/s sustained write; three year warranty.

We don't see any reason to go for this drive over the many cheaper brand name 1TB drives.

★★½☆☆

SOFTWARE

APPS FOR ALL YOUR PLATFORMS

Needs macOS 10.14 onwards | $TBA | adobe.com

Adobe Photoshop Elements 2021

Organise, fix and share your shots more quickly.

Photoshop Elements has always been considered a cutdown version of the full version of Adobe Photoshop. For many years, this was a fair description (especially when Elements lacked key tools such as layer masks.) However, with the release of Elements 2021, the app is less of a cut-down version – it's more of a streamlined one.

The various Guided Edit modes give you easy access to the key tools required to help fix particular picture problems. Thanks to features such as Adobe Sensei AI it also enables you to give your shots a creative makeover without having years of experience with the full version of Photoshop. Elements also boasts unique tools of its own, such as the impressive new Moving Photos effect (which we'll look at in due course).

The Organiser's Smart Tags locate assets by place and time. Smart Tags are now backed up automatically.

Perfect landscapes

One of Photoshop Element's constant strengths is its Guided Edit workspace. This helps image-editing novices to perform a range of practical or creative photo fixes by taking them step by step through a range of tools and techniques. Elements 2021's new Perfect Landscape Guided Edit shows you how to wield all the key tools that will improve a landscape photo, such as straightening a tilted horizon, cutting through haze to reveal more distant detail, and removing unwanted objects (such as people cluttering up a beach). It will also let you drop in a more interesting sky to overcome disappointing weather conditions. It will even change the colours and tones of the landscape to match the transplanted sky – creating a more convincing composite image. Landscapes are a popular subject with photographers so Perfect Landscape is a valuable addition to Element's 2021 toolset. You can share your perfected landscape to Twitter or Flickr directly from the Guided Edit workspace, which demonstrates Elements dedication to getting your work seen by others as soon as you've created it.

The Create menu now provides social media style Quote Graphic templates.

Watch the birdy!

When shooting multiple subjects

– such as a family portrait – it can be a challenge to get everyone looking at the lens at the same time. The Adjust Facial Features command now has a handy Face Tilt tool that enables you to tilt an individual's head up a little and also make them look more to the left or right. The results are subtle, but they can help fine-tune family selfies in which one person is looking at the iPhone's lens while the other is looking at a different focal point. This is a more useful tool than some of the older Adjust Facial Features commands, such as the ability to change the shape of the eyes or lips.

The 'wow!' factor

Social media feeds are bombarded with images designed to elicit 'likes' from friends, family and followers. An effective way to make your stills standout from the crowd is to add motion to them. Photoshop Elements 2021's new Moving Photos tool is designed to take 2D static images and give them an eye-catching animated 3D look. This 3D motion effect is different from the standard 2D Ken Burns zooms or pans produced by apps such as iMovie. The foreground subject (such as a pet or person) moves at a different speed to more distant objects in the photo's background. This creates a similar effect to zooming in or out with a camcorder. You could create this moving photo effect in the full version of Photoshop but it would take a long time. The results produced by Photoshop Elements 2021 are fast, effective and can give a still image the 'wow!' factor. You can then export the moving photo as a lightweight animated GIF that will play in social media feeds on most devices.

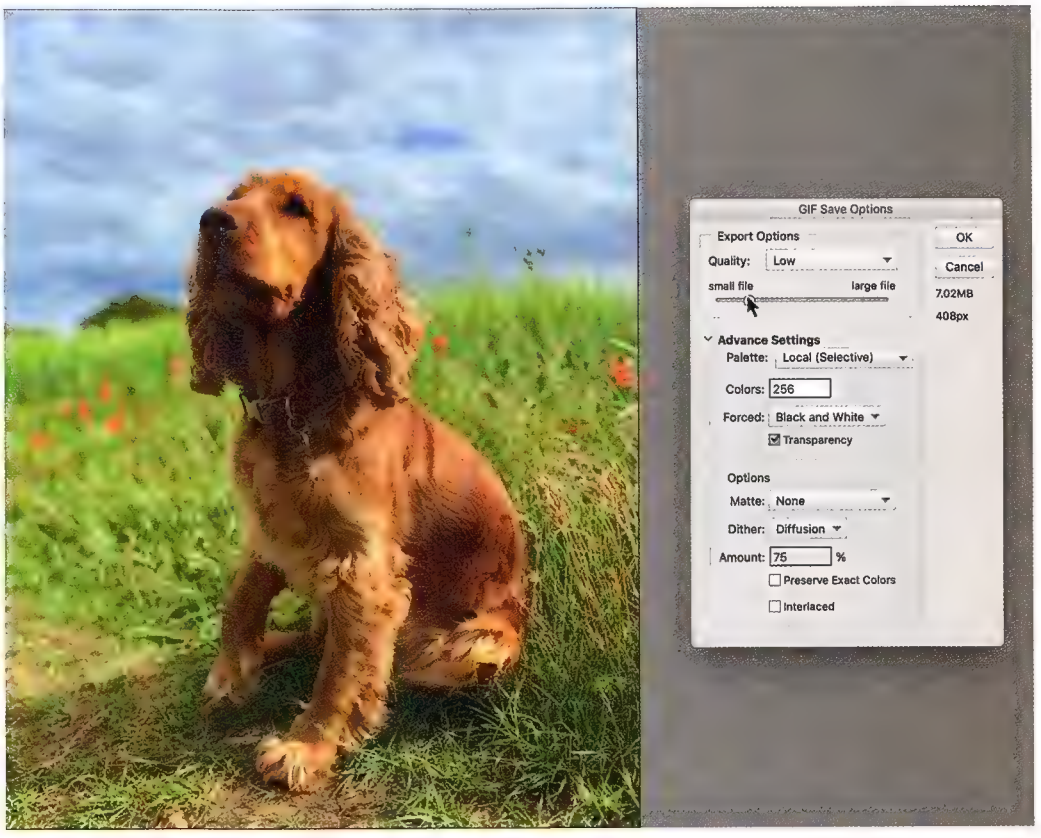
Another new Guided Edit is the Duotone Effect. This enables you to tint a shot's highlights and shadows with separate colours to create a striking and creative arty look that should draw more attention to your Instagram feed. Indeed it will also crop your shot to suit the square shape of an Instagram post before you tint it using a one-click duotone preset. You can then go on to fine-tune a preset's colours to create your own unique looking duotone effect.

Elements 2021 enables a photo-fixing novice to confidently develop skills thanks to its ever expanding collection of Guided Edits. More assured users can export the results of Guided Edits as layered documents that they can fine-tune in the Expert editing mode.

GEORGE CAIRNS

This app give easy access to key photo-fixing and creative tools. An attractive alternative to the full version's monthly subscription.

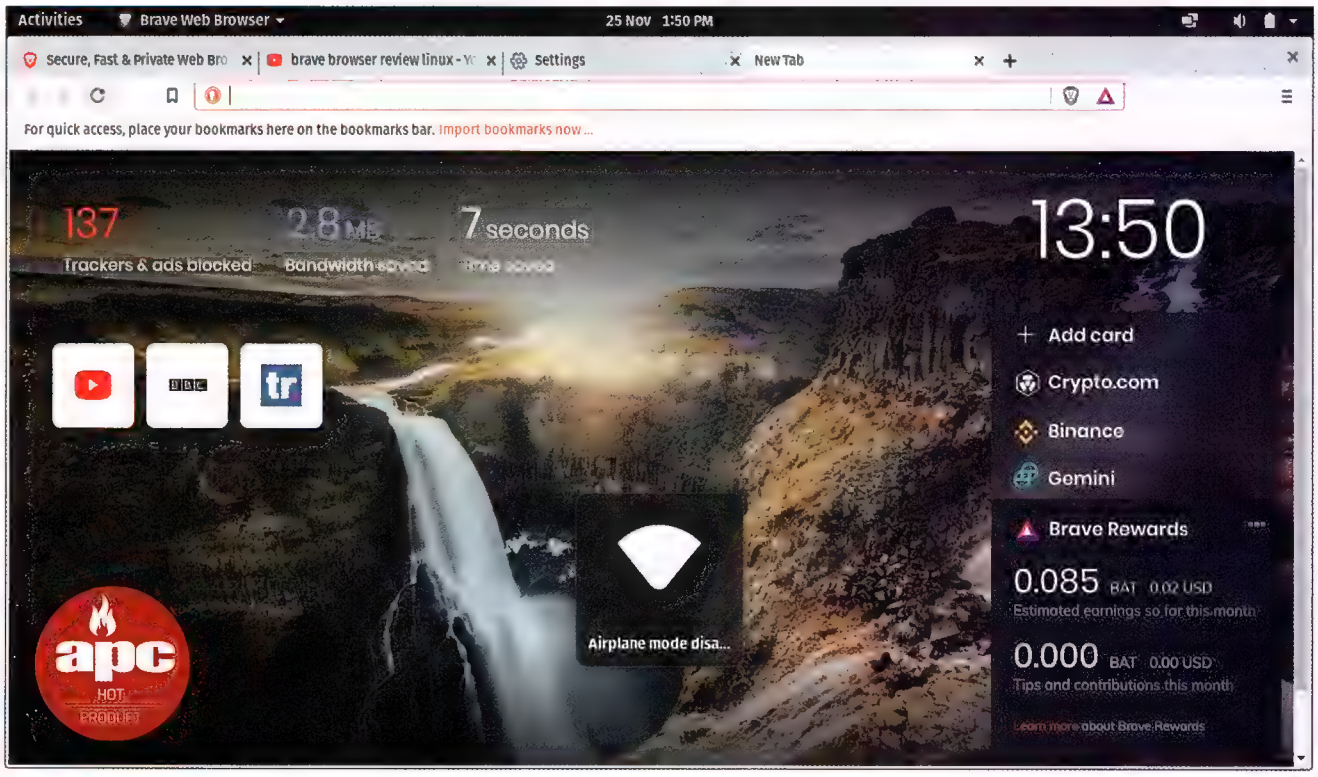
★★★★☆



You can now add 3D movement to your static shots before sharing them as animated GIFs.

"You could create this moving photo effect in the full version of Photoshop but it would take a long time. The results produced by Photoshop Elements 2021 are fast, effective and can give a still image the 'wow!' factor."

Right: Face Tilt enables you to subtly tweak the direction that your subject is looking in. **Below:** The Perfect Landscape Guided Edit helps you make good landscapes look great.



WINDOWS | MAC | LINUX
Free | brave.com

Brave 1.17.3

Firefox loyalist Jonni Bidwell has a dalliance with an altogether different kind of web browser.

We're big fans of Firefox, but it isn't the only option, and the Chromium-based Brave browser has over its five-year lifespan attracted a considerable following. Brave is licenced under the permissive Mozilla Public License.

Brave Software is open source and there are versions for Windows, Mac and Linux. Installation is as simple as any other browser, and for Linux it's just a matter of adding a repo, or, if you want to embrace the future, fetching it from the Snap Store. On first run there's a brief welcome tour, which offers to import settings and bookmarks from other browsers, explains how to disable its ad-blocker feature (in case sites don't behave), gives you a choice of default search engines (use DuckDuckGo!) and asks you to enable Brave Rewards.

Turning on the Brave Rewards option will mean unintrusive ads will periodically appear. However, if you view enough of them you'll be rewarded in cryptocurrency – Basic Attention Tokens (BAT) to be precise. These can be traded on many crypto exchanges, either for Bitcoin or hard currency, or you can use them to tip your favourite content creator (similar to how Steemit and LBRY work). You can also donate BAT directly to your oft-visited Reddit, Twitter and GitHub contributors. Brave also has its own crypto wallets, so you can manage your BAT, ETH or BTC from the comfort of your browser.

Nobody likes ads, but they're unfortunately central to today's revenue models, so we'd rather see ones that directly fund creators and projects rather than horrible advertising networks. Brave uses its own Privacy-Preserving Product Analytics (P3A) to target ads and avoid the tracking associated with other services. Brave's ad network returns 70 per cent of its revenue to users, so this is anything but a money grab. It seems a little cheeky to block a webpage's own ads only to run your own, but we like cheeky.

We found casual browsing to be snappy with Brave and struggled to find any site (that's worth your time) that required the adblocker to be disabled. Even our sister site and ad haven *TechRadar* didn't bat (no pun intended) an eyelid.

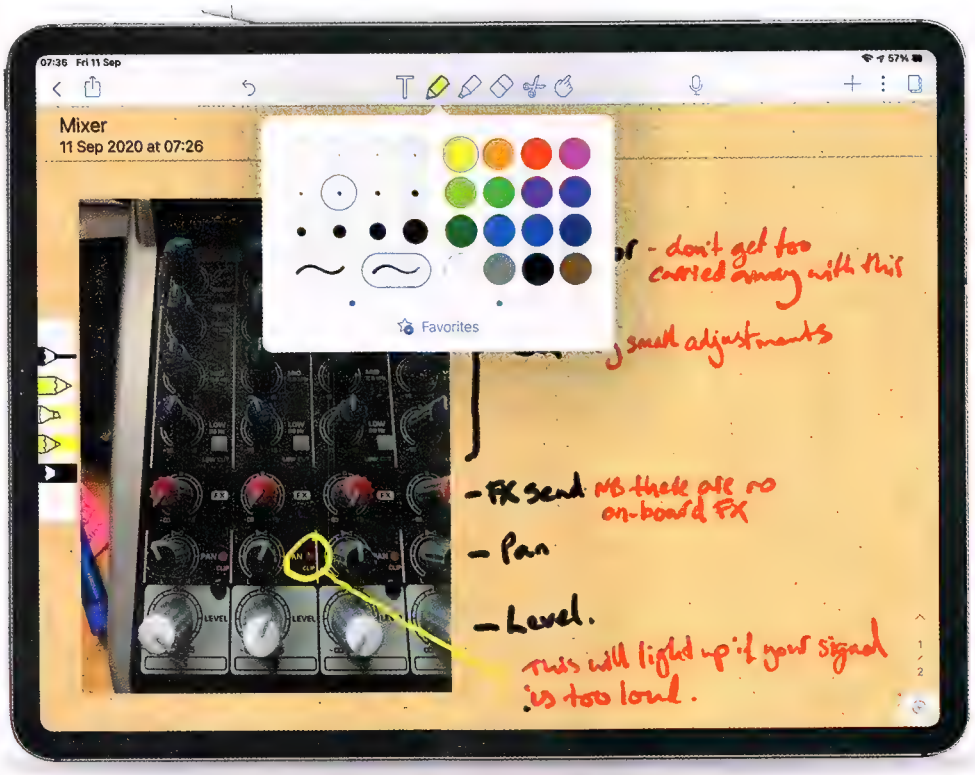
The ad-blocking engine is written in Rust and hardware acceleration is enabled by default. If you browse to **brave://gpu you** can see what features are enabled. We were pleased to see that installing Brave on our Pop-powered Dell XPS 13 gave us WebGL2 rendering out of the box. To get accelerated video decoding to work we had to enable an experimental flag, but then it worked just fine.

Brave's home screen shows you how many ads you've been spared, your BAT earnings, and a pretty backdrop to boot.

Besides privacy from advertising, Brave also offers privacy from snoopers in the form of a built-in Tor Browser. Brave Software has its own onion site, and when you browse **https://brave.com** the address bar gives you the option to instead open the Tor site. You can only browse Tor in a private window, which makes sense security-wise. There are a number of nice touches that make Brave stand out, such as it giving you the option to open a page using the Wayback Machine when a 404 not found error is encountered.

JONNI BIDWELL

Brave really is a better browser, even if you don't care about its rewards program. ★★★★½


07:35 Fri 11 Sep
Mixer
11 Sep 2020 at 07:26
Favorites
- don't get too carried away with this
small adjustments
- FX send NB these are no on-board FX
- Pan
- Level.
This will light up if your signal is too loud.

iOS

needs iOS 12 or later | $8.99 | gingerlabs.com

Notability 10

A superb note-taking app.

Notability is one of our favourite note-taking apps for iPad. It enables you to combine handwriting, illustrations, images, typed text, audio recordings, and external files such as MP3s in a single document; it enables you to import PDFs or scan printed documents and annotate or highlight them; and it has good support for a wide range of cloud-based services. It's particularly good with the Apple Pencil on compatible iPads but it also works well on iPhone, and there's a desktop version for easy syncing between mobile and desktop.

The biggest change in version 10 is the arrival of the new Notability Shop, which enables you to purchase additional features, stickers, and themes. One of those features is handwriting conversion, which was formerly part of the app but now exists as a $2.99 IAP. The price of Notability has been reduced partly to reflect this: it's now $8.99 compared to $11.99 before. The handwriting recognition is worth the extra: our handwriting is appalling but Notability didn't have any problems decoding it.

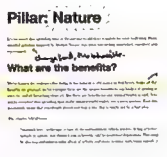
At launch, the Shop wasn't particularly well stocked – handwriting recognition was the only item in Technology and the 2020-2021 Digital Life Planner was 'coming soon'. But the prospect of being able to add planners and additional features is interesting.

Handy snaps

There are three other key changes in Notability 10. The first is the Favorites tool bar, which doesn't look like much but is really useful. It enables you to snap your favourite ink styles to it, so for example if you tend to use the same brush and colour for writing notes, or the same highlighter settings in PDFs, you can stick those settings into the Favorites tool bar for one-tap access.

Next there's the Style Popover, which has been extended to make more room for the brush, colour and width selection, and has new brushes for you to draw lines and shapes with dotted lines. Finally, the line snapping that made it easy to draw straight lines has been extended to arrows and curves for smoother drawing.

The bigger Style pop-up can save specific combinations to the new Favorites bar.



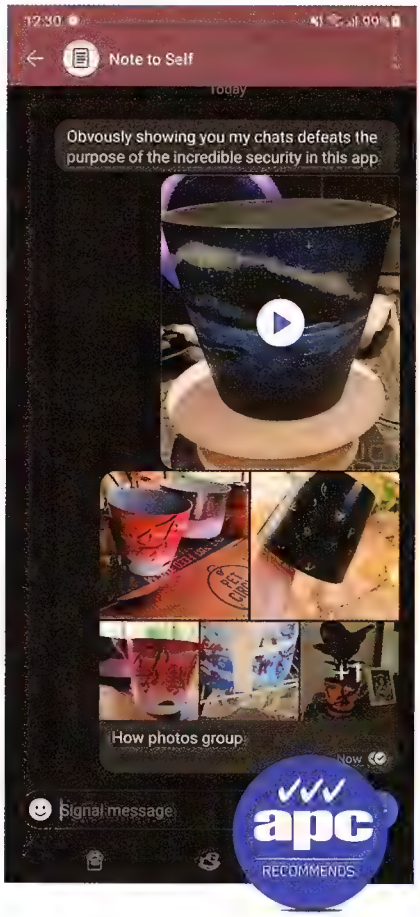
Notability makes it easy for you to combine text, images and recorded audio in one note.

If you're not sold on the Notability Shop then this isn't really a huge update, but Notability 10 is a refinement of an already very impressive, flexible, and useful app. The combination of note-taking, (optional) handwriting recognition and audio recording means it's really good for lectures and meetings, and the Voice Boost feature does a good job of making distant voices louder. And with support for a wide range of key file formats, it's a handy app for importing and organising multiple kinds of information from multiple sources.

CARRIE MARSHALL

Notability is a superb note-taking app with lots of flexibility. It's ideal for a variety of projects.

★★★★★



ANDROID (&IOS)

Signal

Boosting.

Free

This messaging app has been a staple for many who are concerned with privacy but it recently exploded in popularity. This came in part thanks to a confusing update to WhatsApp which implied more sharing of user data. But Signal is pretty good in a lot of ways – I've been using it for years now so it deserves a mention. It's easily one of the best and most transparent services out there when it comes to security. This is because it's all done by the Signal Technology Foundation – a non-profit that's all about open-source privacy. Signal's encryption isn't opt in, like a lot of other services so you have it by default. The app is a bit no frills when it comes to stickers and other gimmicks. There's a pretty tight limit on video files you can send, and it's just not exactly the prettiest. However, if you want a messaging app that puts your security first, it's a really good choice.

HOPE CORRIGAN

★★★★☆

Android (&iOS)

Video Crop & Trim

Or just Crop.

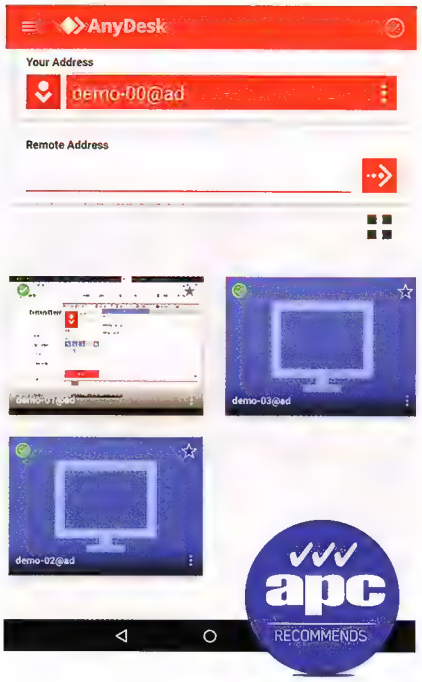
Free / $2.99 per month

It's always nice when an app does exactly what it says on the tin. I needed to crop a video and nothing preinstalled on my device can do that. So I did a fairly basic search for an app that suited my needs and came across this one. There are a bunch out there so I picked the one with the best and most genuine looking ratings. Video Crop & Trim is a free app that has a paid subscription model if you want extra features. As all I was looking for was something to crop, the free variant works really well. There are even helpful presets for things like standard instagram sizes and other social media too. The free version will show you an ad while it processes the video, but if you just want a quick and easy tool to use occasionally, it's simple and does a good job. As an added bonus it also doesn't leave a watermark, which is pretty neat for a free app.

HOPE CORRIGAN

★★★☆☆

"It's a great alternative to TeamViewer, which has been known to lock people out of accessing its free version pretty arbitrarily."



Android (&iOS)

AnyDesk

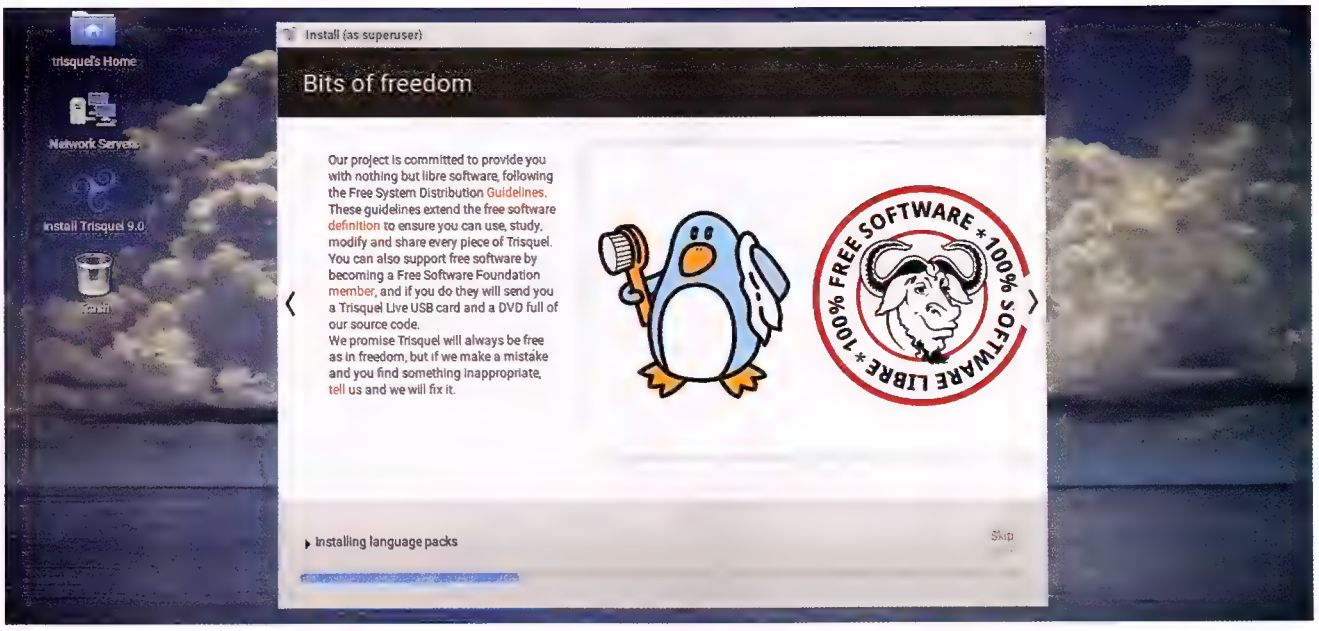
Rising star.

Free / up to $53 a month

Another app that's been around for a little bit now but seeing an uptick in popularity is AnyDesk. This is an app that, when installed on each device, allows you to let one control the other via remote desktoping. It's a great alternative to TeamViewer, which has been known to lock people out of accessing its free version pretty arbitrarily. Both AnyDesk and TeamViewer have a free option designed for private use, but many users have found themselves unable to access TeamViewer's despite only using it in their homes. I'm one of them. So I turned to AnyDesk, which does a really good job. You can set it up so all devices on your network are automatically included to connect to and have passwords so you don't need to be at a device to allow remote access. Recently, an option to automatically lock a device once you disconnect from the session has been added too. AnyDesk is really catching up to TeamViewer in functionality, and I can actually use it.

HOPE CORRIGAN

★★★★☆


trisquel's Home
Network Servers
Install Trisquel 9.0
Trash
Install (as superuser)
Bits of freedom
Our project is committed to provide you with nothing but libre software, following the Free System Distribution Guidelines. These guidelines extend the free software definition to ensure you can use, study, modify and share every piece of Trisquel. You can also support free software by becoming a Free Software Foundation member, and if you do they will send you a Trisquel Live USB card and a DVD full of our source code.
We promise Trisquel will always be free as in freedom, but if we make a mistake and you find something inappropriate, tell us and we will fix it.
100% FREE SOFTWARE * 100% SOFTWARE LIBRE *
Installing language packs
Skip

Linux | trisquel.info

Trisquel 9.0 Etiona

Jonni Bidwell is on a brave quest to banish binary blobs from his legendary Eee PC. Will this distro prove helpful, or become more of a hindrance?

The world is full of people shouting and clamouring for the latest thing. So it's always reassuring to discover places where things still move slowly.

Nowhere is this more true than Trisquel, the freedom (as in speechdom) -loving, Ubuntu-based distro endorsed by the Free Software Foundation. Trisquel used to push out one release a year (based on the corresponding Ubuntu LTS release), but it's been over 18 months since the previous release. And that one took over three years to come into fruition. This new release is based on Ubuntu 18.04, the second-to-last LTS release, which is supported until 2023.

Trisquel replaces Ubuntu's kernel with Linux-libre, which has had all the proprietary firmware blobs (and any drivers that reference them) removed. Further up the stack, things have been purified, too. Trisquel uses its own repos. As such, it's one of only a handful of distros (including Hyperbola and Parabola, neither of which have aught to do with geometry) to be approved by the Free Software Foundation.

With this release Trisquel moves from Xfce to the MATE desktop, so if you long for those Gnome 2 vibes then this might be for you. ISOs are getting bigger and Trisquel's weighs in at a 2.6GB. A 1.2GB mini-image is available that runs LXDE – ideal for older machines. There's also Triskel, a KDE spin, and Trisquel Sugar Toast which is an educational release. Oh and there's a tiny Net Install image too if you want to build a minimal but freedom-loving OS from the ground up.

One benefit of being based on the older Ubuntu release is that 32-bit editions are available, a rare thing these days. Don't get too comfortable, though: when Trisquel 10 (which will be based on Ubuntu 20.10) is released, there'll be no upgrade path for 32-bit users.

Installation was smooth and offered the encrypted install as well as LVM options. A smattering of freedom-respect applications are installed. Abrowser is the default browser. There's the Electrum Bitcoin wallet so you can manage your cryptocurrency nest egg. And if you want to do social media in a way the FSF approve of, there's a client for the Jami decentralised social network. It's hard to find a good RSS feed reader application these days so we were pleased to find the venerable Liferea included too. Plus there's the Seahorse utility for managing passwords and keys.

This penguin has been deblobbed, we're told the process is entirely painless.

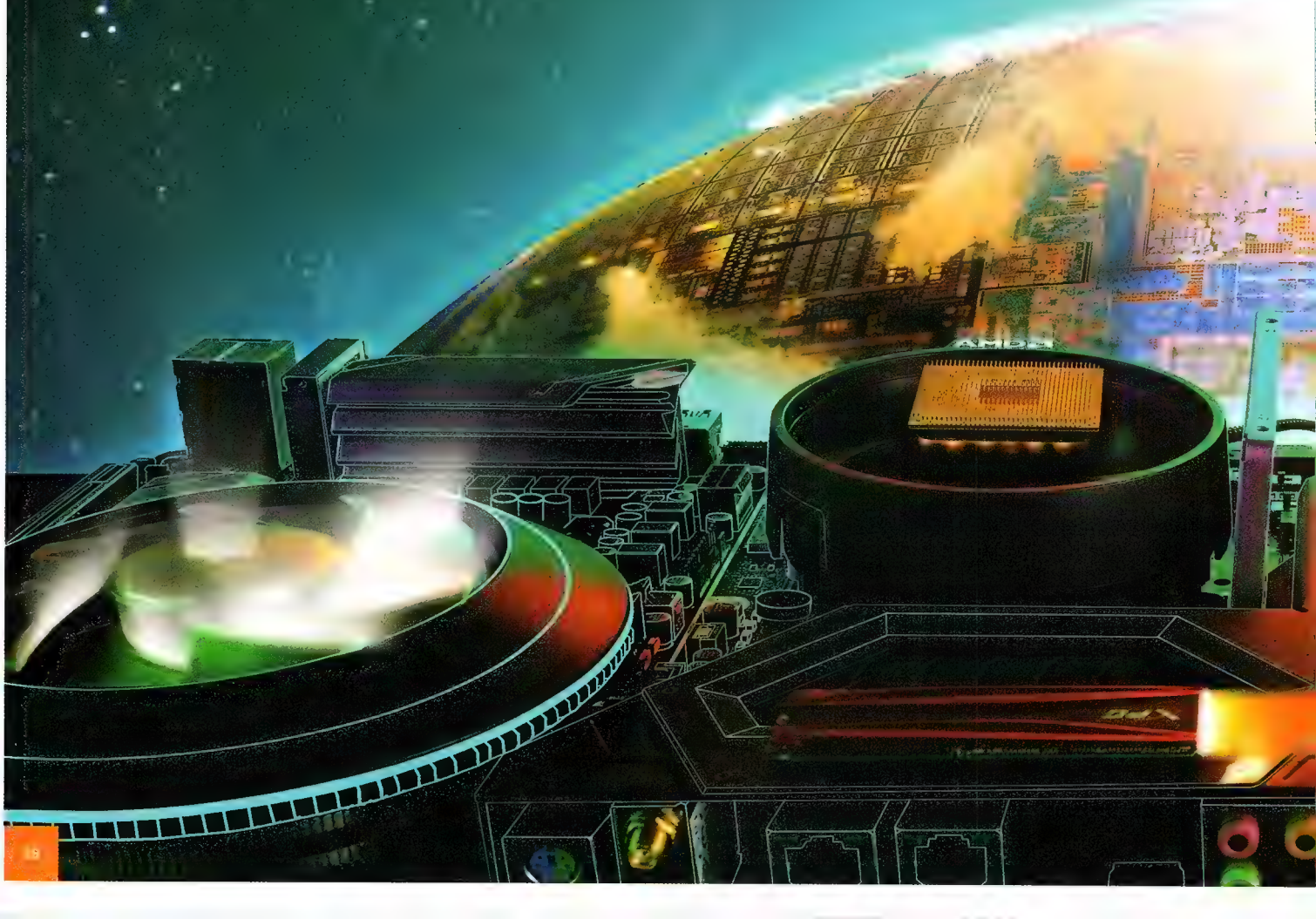
Overall it's a slim package selection, which probably suits the target audience. The Snap daemon isn't included and neither is Ubuntu's software centre (it's a gateway to proprietary software). Graphical package management is available via the old school but still quite cool Synaptic. Trisquel has an avid user community, and you'll find help if you need it on the forum. Documentation is a little sparse, but there's a hardware wiki and well thought-out (but sometimes incomplete) guides for common tasks. More often than not, the Ubuntu documentation will cover most things that you might find yourself looking up.

If you don't have strong views on free software, and would rather have working Wi-Fi and other modern conveniences, then there's little reason to check out Trisquel. But if you do, and you're looking for something to install on your Libreboot-running, deblobbed Thinkpad daubed in FSF stickers, then this will surely float your boat.

This is a no-nonsense distro that is considerably free-er than most free software.

★★★½☆

TECH PREVIEW 2021



THE *APC* TEAM PREDICT WHAT THE COMING YEAR HAS IN STORE FOR THE WORLD OF TECH.

It feels like an old and tired mantra at this point, but it's fair to say that 2020 was an awful and very challenging year. It's shown us just how dependent we are on that humble transistor. Life has changed, for better or worse, and the world we once knew likely won't exist in the same way it did when this pandemic ends. If the science comes true, and as population sizes swell, diseases like this will likely become far more commonplace. And with it there'll no doubt be an even greater shift in how we work, how we enjoy our spare time, and how we connect with our loved ones.

We're seeing this change happen already: More of us now than ever work from home, and the majority are keen to see that trend continue even after this period in history ends, at least on a flexible basis. In fact, although economies have faltered and gone into sharp recessions across the globe, perhaps unsurprisingly, the one area that hasn't been negatively impacted by this colossal moment in time is the tech industry. If anything it's boomed, as more of us have demanded faster processors, better connectivity, and new PCs, and because of that supply can't keep up with demand.

The technologies that launched in 2020 have been nothing if not impressive. We've seen new GPUs from AMD and Nvidia that have begun to really raise the feasibility of 4K gaming; processor leaps that have disrupted long-time industry kings; more impressive monitor tech at far better prices; and an arsenal of new ergonomically designed peripherals – and even more have made their way into the design stages already.

At any other time in history, these launches would've been considered legendary. We've been absolutely spoiled with some incredible hardware over the last few months. Yet as the madness that is 2020 has now come to a close, this is truly only the beginning. As always, new trends, demands, and repercussions in innovation and design take time to make it to market, and the effects of COVID-19 on the industry and on the PC enthusiast community as a whole will only begin to be really felt later this year.

So what is coming? What can we expect? And what tech are we likely to see pop into existence? Well we've got the whole gang back together to give you the very best lowdown on the future tech of 2021.

THE CPUS OF TOMORROW

INTEL VS AMD, THE BATTLE CONTINUES

2020 ended with a bang on the CPU front, with AMD's Zen 3 architecture claiming the overall CPU crown. Looking forward to 2021, Intel hopes to reclaim some of its lost glory, but AMD isn't resting on its laurels either.

After a busy 2020, AMD doesn't have plans for a completely new architecture this year. Zen 4 is in the works, but it's slated for 2022 – it will be made using TSMC's N5 5nm lithography, likely with DDR5 and PCIe Gen5 support, and a new socket. Considering that Zen 3 just launched for desktops at the end of 2020, most of AMD's 2021 plans will involve rolling out Zen 3 across the rest of the portfolio. That means everything from mobile chips to servers, with additional Ryzen desktop SKUs as needed.

On the server front, AMD's Milan chips are expected to fill the same niche as the existing Zen 2 Rome chips, and will drop into existing motherboards. They'll top out at 64-core/128-thread versions, but instead of Zen 2 compute chiplets, they'll be upgraded to Zen 3 chiplets that have a unified 32MB L3 cache and a single core complex, plus all the other architectural enhancements. Naturally, we'll see the same designs show up in Threadripper 5000 variants for HEDT builds. A 32-core/64-thread Threadripper 5970X seems a given, and a 64-core 5990X may or may not see the light of day.

At the other end of the spectrum, laptops are due to get not just one but two potential upgrades this year. Cezanne is slated to use an eight-core Zen 3 CPU paired with a Vega 7 GPU, all in a monolithic die. Frankly, we're a bit tired of seeing the Vega GPUs as the only current option in AMD integrated graphics. Which is why AMD also has Van Gogh in the works – except that will apparently pair Zen 2 CPU cores with a Navi 2x GPU, according to the latest roadmap leaks. It seems likely that Van Gogh will go after the 7.5-18W range, meaning it's targeting Intel's Tiger Lake, and will probably have a four-core/eight-thread CPU. As for the Navi 2x graphics, it's difficult to imagine AMD cramming ray tracing into integrated graphics, so it may be more of a Navi 1x design in a lot of respects.

Flipping over to Intel, the company is looking to strike back at AMD's Ryzen 5000 chips with Rocket Lake, which will have backported Cypress Cove CPU cores – basically, those are Ice Lake's Sunny Cove cores, but on 14nm+++ instead of 10nm. It's a bit of a mess, but Intel claims it will deliver more than a 10 percent IPC (Instructions Per Cycle) increase relative to the current Comet Lake, and could still clock as high as 5GHz. Rocket Lake will also support PCIe Gen4 and feature Intel Xe integrated graphics. The big problem is that it will top out at eight CPU cores, which is a step back from the current 10-core i9-10900K. In short, it won't be able to touch AMD's 5900X/5950X multi-threaded performance.

Intel has a second completely new CPU architecture slated for 2021 as well – Alder Lake. This is where things really get interesting. Alder Lake will be a hybrid CPU design, sporting up to eight Golden Cove high-performance CPU cores, and eight Gracemont low-power cores. Unlike Rocket Lake, Alder Lake will be manufactured using Intel's SuperFIN 10nm node, making it the first 10nm desktop CPU from the company. It will also move to a new LGA1700 socket, with DDR5 memory support, and will continue to leverage Xe Graphics on the GPU front. It sounds impressive, but the hybrid design could make things messy on Windows, which isn't that great at figuring out how to balance loads across cores of potentially wildly different performance.

Finally, Intel also has Tiger Lake-H CPUs slated to launch for laptops in 2021. These will pack up to eight Willow Cove CPU cores and should offer a substantial boost to performance. It's interesting that Intel hasn't mentioned any plans to release Tiger Lake on the desktop – normally high-end laptops use the same chips found in desktops, just limited to lower power levels. Maybe Intel thinks that Alder Lake already covers this sector, but then why not just do Alder Lake for laptops as well? Either way, 2021 is shaping up to be very interesting in the CPU sector.

BREAKING GRAPHICAL LIMITS

ITERATIONAL CHANGES AND MORE MID-RANGE COMPETITION?

Last year was pretty slow-going on the GPU front, right up until September, when Nvidia blew open the doors with its new Ampere architecture and RTX 30-series graphics cards. AMD followed suit with the RX 6800 series in November and December. Considering 2020 ended with an explosion of GPU launches, we don't anticipate anything radically new for 2021. Which isn't to say there won't be a ton of new GPUs coming out; they'll just be more iterative and will go after the mainstream and budget markets, rather than going out and delivering new levels of performance. Probably, anyway.

AMD's Radeon RX 6800 series has launched, bringing with it

AMD's Ryzen 9 5900X is packing awesome single-threaded and multi-threaded performance. AMD doesn't plan on replacing it in 2021.

Nvidia's RTX 3060 Ti continues the Ampere march downward.

© AMD, NVIDIA, Ig

the new RDNA2 architecture and a whopping 128MB Infinity Cache. Performance in traditional games is right up with Nvidia's best, but turn on ray tracing and things aren't looking as promising. So where does AMD go from here?

For 2021, we expect RDNA2 to trickle down to lower tier products, with the RX 6800 XT and the RX 6900 XT staying at the top of the product stack. We expect to see RX 6700 XT and RX 6500 XT models at the very least, probably RX 6700 and RX 6500 as well. But scaling RDNA2 down from Navi 21 presents some interesting challenges.

AMD talked a lot about its Infinity Cache for the biggest chip, but there's pretty much no way that AMD can put a 128MB cache in the mainstream and budget variants. We've already seen that the 128MB cache doesn't benefit 4K gaming as much as 1440p and 1080p, but will a 64MB or 32MB Infinity Cache still be sufficient? We'll likely find out later this year.

Navi 22 is the rumored mainstream offering, with 40 CUs and a 64MB Infinity Cache. It might end up with 12GB of memory, or potentially 8GB. It will be a mainstream part. Below that is Navi 23, the pseudo-budget part with a 32MB Infinity Cache. There may even be a Navi 24 chip, but it's difficult to imagine RDNA2's full feature set (including ray tracing) scaled down that far. Then again, Xbox Series S exists, so we might get a PC equivalent.

On the Nvidia front, right now the lowest tier Ampere part is the RTX 3070, but it will be joined by the RTX 3060 Ti. It's the same GA104 chip, with the same 8GB of GDDR6 14Gbps memory; it just trims the chip down to 4,864 CUDA cores and 38 SMs (compared to 46 SMs on the 3070). That should mean about 15 percent less performance. Compared to the outgoing RTX 2060 Super, it should be a healthy step up in performance – Nvidia claims it will be five to 10 percent faster than the RTX 2080 Super, and around 40 percent faster than the 2060 Super.

Where there's an RTX 3060 Ti, there's bound to be an RTX 3060. That will use a new GA106 chip, with 6GB of GDDR6 memory and a rumored 30 SMs (3,840 shader cores). GA106 is also rumored to show up in RTX 3050 Ti, with the same 6GB memory and 26 or 28 SMs. Below that there's talk of a GA107 with 18 or 20 SMs and 4GB of GDDR6. It's difficult to imagine such a card getting acceptable ray-tracing performance, but maybe for 1080p with DLSS?

Nvidia is also likely to have beefed up RTX 3070 Ti and RTX 3080 Ti models coming in the future. After all, AMD is winning on the VRAM front right now, but doubling to 16GB GDDR6 on the 3070 Ti and 20GB of GDDR6X on the 3080 Ti would solve that problem. Considering the 6900 XT will likely close the gap with the RTX 3080.

There's also an outside chance that Nvidia does a refresh of Ampere later in the year, shifting to TSMC's superior N7 or N7P node. Ampere GA100 is already on N7, so it may not be that difficult. TSMC delivers higher density and efficiency as well, and stranger things have happened. More likely, the next big move from Nvidia will be Hopper in 2022, built on TSMC N5 with EUV lithography. It will go up against AMD's RDNA3.

PUSHING PIXELS PER INCH

SAY GOODBYE TO BEZELS AND HELLO TO AFFORDABLE HIGH-REFRESH 4K

Five years ago, the future of PC displays was almost certainly OLED. Now we're not sure that's ever going to happen. Yes, OLED technology has a small foothold in the laptop PC segment. but as yet, OLED desktop monitors are virtually non-existent.

For 2021, that isn't going to change. In fact, it's very likely that the next big thing in PC displays will be microLED, not OLED. But, again, microLED is far from imminent. So what will change in 2021 when it comes to PC displays?

In strict technological terms, not much. There will be little to nothing that's substantially new. Instead, you can expect to see existing technology become cheaper and improve incrementally.

As for the specifics, don't expect any huge revolutions in the actual LCD panels that go into desktop and laptop displays. Marginal improvements in areas like contrast and pixel response are reasonable, but not major step changes. To put this into context, over the past 10 years IPS-type panels have seen static contrast improve from around 1,000:1 to 1,300:1, and native pixel response, as opposed to overdriven response, improve from around 25ms to something closer to 10ms.

LCD technology tends to improve only gradually. That notion extends to screen resolution. The last big leap was the jump to 4K or UHD and 3,840 x 2,160 pixels. While that makes for a huge number of pixels – over 8 million – it doesn't necessarily translate into a true high-DPI display, at least in desktop terms.

A 27-inch 4K panel, for instance, translates into 163 pixels per inch. While that's decent, a true high-DPI display probably requires something closer to 200 pixels per inch, albeit assumptions regarding viewing distance are inevitably involved.

Obviously, larger displays of 32 inches or more only transport the viewer even further away from that high-DPI experience. The solution for those seeking a high-DPI experience on the PC is

AMD's RX 6800 is out, and represents the current bottom of RDNA2, but it will be joined by mainstream and budget RDNA2 alternatives later this year.

Slim bezels along with mini-LED and more affordable 4K high refresh are among the highlights for screens in 2021.

more pixels in general, and 8K more specifically. That's 7,680 x 4,320 pixels. At 32 inches, 8K works out as 190 pixels per inch. However, while the TV market is beginning to see the first examples of what you might call non-exotic if not truly affordable 8K screens, 8K remains a rare beast in PC monitors.

While 8K is not going to be the norm anytime soon, a few more 8K-capable monitors should appear next year, as the product road maps from the major panel makers proves. Those road maps provide cause for cautious optimism in other areas, too.

Take LG Display, the inventor of the IPS panel and one of the biggest suppliers to monitor makers. For 2021, LG has a new 31.5-inch 8K IPS panel. It's a fairly conventional panel in other regards, with a peak brightness of 400cd/m2. But it will hopefully be the basis of a new series of slightly more affordable 8K monitors.

LG is also planning a new generation of panels with mini-LED backlights. These go beyond existing "full array" backlights used to achieve local dimming in HDR monitors by dramatically increasing the number of dimming zones. Peak brightness is also expected to jump up to as much as 1,250 cd/m2. Those two developments should see the arrival of the first PC monitors that truly deserve to be sold as HDR capable.

One early example from LG is a 31.5-inch IPS panel that should be available to monitor manufacturers in early 2021. It has slim bezel on all sides, packs 3,840 x 2,160 pixels and a backlight with more than 2,000 mini-LED zones, and HDR 1,000 certification.

Other interesting panels in LG's lineup for 2021 include another more affordable 31.5-inch 4K panel, this time with 144Hz refresh support but a more conventional full-array backlight. More broadly, LG will be releasing a new generation of what it calls "Oxide" panels with super-slim sub-3mm bezels on all four edges of the panel. Other LG panels to look out for include a 40-inch IPS model with 5,120 x 2,160 pixels, and a number of 240Hz IPS panels.

Meanwhile, one of LG's cut-price competitors has a few interesting panels in the works. AU's upcoming 27-inch panel combines its take on IPS (known as AHVA) with ultra-slim bezels, 4K resolution, and 95 percent of the DCI-P3 colour space.

Along with a number of high-refresh 1080p and 1440p AHVA panels, arguably one of AU's more exciting panels is a 32-inch AHVA 4K model with 144Hz refresh, 10-bit colour, slim bezels, and a 1,152-zone mini-LED backlight capable of 1,400 cd/m2 peak brightness. Just as exciting for PC enthusiasts on a tighter budget, AU has a new 32-inch 144Hz panel with a more conventional (and cheaper) edge-lit panel coming too.

All told, mini-LED, more affordable high-refresh and 4K panels look to be the major trends for next year, from the small band of manufacturers who make the panels that go into monitors from a wide range of brands. In other words, a reasonably affordable 32-inch, 144Hz 4K monitor with IPS-quality visuals might just be a thing in 2021. Meanwhile, an 8K monitor priced nearer $2,000 than $6,000 could be on the cards. Granted, neither of those options is as dramatic as a wholesale shift to microLED. But should they come to pass, they would still be very welcome developments.

STORAGE IN 2021

PCIE 4.0 GOES MAINSTREAM, AND INTEL'S OPTANE LEAVES THE CONSUMER MARKET

Speaking of technological revolutions that never happened, both Intel's Optane and Samsung's Z-NAND have been duds since their inception, at least in contrast to the promise they suggested at launch. Neither of these new alternatives to NAND flash memory have become the technology of choice for persistent solid-state memory. That doesn't look likely to change in 2021.

Samsung has gone conspicuously quiet concerning Z-NAND. As for Intel, its Optane technology has now been canned, at least on the consumer front. Intel will continue selling Optane products to the enterprise market, while evolving the technology. That could mean an eventual return to the consumer space for Optane, but hopes aren't high.

Intel has spoken in vague terms about "many millions" of IOPS performance. If that turns out to be true, Optane 2.0 will set new standards for random-access performance. However, we aren't expecting the second coming of Optane to deliver that performance for a price anywhere near traditional NAND flash drives, so it's likely to remain a niche and pricey enterprise storage option.

Back in the mainstream, the big news for 2021 will be the wider adoption of PCI Express 4.0 interfaces on otherwise fairly conventional NAND drives. Of course, PCI Express 4.0 is not new per se for 2021. Compatible drives, motherboards, and CPUs were already available in 2019, but only on AMD platforms. For 2021, Intel will belatedly join the party with its upcoming Rocket Lake chips, which will bring native PCIe 4.0 support.

As for Intel-flavored motherboard support, the good news is that Rocket Lake is backwards compatible with existing Intel 400-series chipsets. Many existing Intel 400-based

Samsung's 980 Pro is among the new breed of super-fast PCIe 4.0 SSDs.

Next-gen games console tech is set to accelerate PC storage performance in 2021.

© Samsung, FKWB, Noctua, Anandtech

motherboards may be able to support PCIe 4.0 courtesy of a Rocket Lake CPU and a BIOS update. However, we would advise caution and refer to the board manufacturer before jumping to any conclusions.

In any case, PCIe 4.0 essentially doubles raw bandwidth over PCIe 3.0. As we've seen with the new Samsung 980 Pro, it can translate into pretty epic peak performance. On our testbed, the 980 Pro cranked out 7GB/s of read performance and 5GB/s of write, though the increase in random-access performance was slightly less dramatic. Regardless, PCIe 4.0 should become the norm for new PCs in 2021.

The console connection

One of the many highlights of the two new games consoles from Microsoft is a new approach to storage and indeed a greater focus on storage performance. Happily, the technologies involved are going to spill over to the PC.

Most notable is Microsoft's DirectStorage, a member of the broader DirectX API. According to Microsoft, even with super-fast PC hardware and a modern NVMe SSD, games using the existing APIs are unable to fully saturate the IO pipeline leaving precious bandwidth on the table.

The specifics of DirectStorage are complex. But the 10,000ft overview involves measures such as combining what were once thousands of sequential IO requests into batched, many-at-a-time parallel IO requests.

Existing storage APIs also incur a lot of "extra steps" between an application making an IO request and the request being fulfilled by the storage device, resulting in unnecessary request overhead. With a supported NVMe drive and properly configured PC, DirectStorage will be able to detect up front that these extra steps are not required and skip all the unnecessary checks/operations, making every IO request cheaper to fulfill.

Admittedly, DirectStorage and its companion technologies are aimed primarily at improving gaming performance. But it may also have wider implications for PC storage performance too.

THE WORLD OF COOLING

CHILLING THE FUTURE WITH NANO-COOLANT AND PELTIER EFFECTS

PC cooling is in a bit of a weird place at the moment. Processors are getting hotter, it's an observable fact. Whether you're looking at Intel or AMD, the race for faster chips is leading to the generation of more heat. You can see this in Intel's latest design push with its 10,000-series processors. The larger die and socket size, and the thinner IHS help dissipate heat more efficiently – it's happening because of that increased heat generated by higher performance and more voltage. The same is true of AMD: Team Red has a slight advantage, as its mainstream consumer processors are larger than Intel's, and the IHS has almost always been soldered on, but we're still seeing temps creep up in the mid-to-high 50s and 60s at idle, with a solid 240mm AIO cooler.

The world of graphics has followed a similar pattern, with both Nvidia's latest RTX 3000-series and AMD's Radeon RX 6000-series cards featuring more complex fan designs and beefier two and a half slot coolers to help dissipate the excess heat generated by the introduction of ray tracing and denser GPU cores.

We're starting to see this spill over into the world of cooling design as well. In the custom loop world, EKWB has just debuted its EK-QuantumX Delta TEC water block. This is a very unique style of Intel CPU block, more aimed at the high-end overclocker than the average person, but what it does is provide sub-ambient temperatures across the processor by taking advantage of a Peltier/thermoelectric cooler plate.

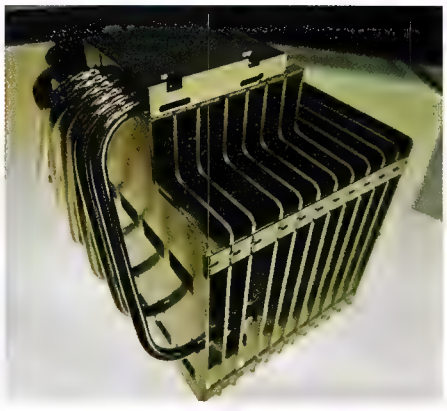
Sub-ambient cooling

Think of a TEC or Peltier device as a form of solid state refrigeration. In essence it has a single piece of thermally conductive material in it. When a current flows through that material, it pulls thermal energy from one end of the material to the other end. What that does is cool the side that's losing that thermal energy, and pushes the excess heat to the other end, which is typically attached to a heatsink operating at ambient room temperatures.

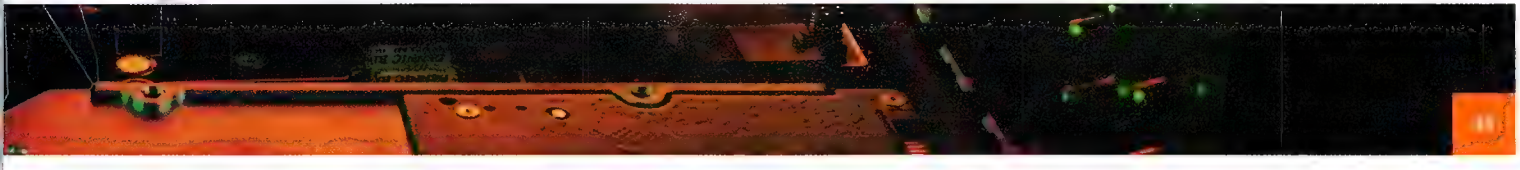
In EKWB's case, unlike its usual waterblocks, Only the TEC itself makes contact with the processor directly. When installed in a loop, the coolant cools the heatsink attached to the TEC, pulling that excess heat away from the TEC and into the radiators. It's worth pointing out that this is not really an efficient way of cooling something. It uses additional power to perform

TEC style solutions could become the standard for the future of processor performance.

A chromax variant of this epic fan would be much appreciated.



Noctua's fanless heatsink is a monster tower, with an impressive aluminum fin design.



Nano Coolant AIOs

We've spent a lot of time working with Mayhems over the last few months on its XTR coolant. It still continues to impress us as far as coolant goes, but it's fair to say that it is very niche, especially for the mass market.

However, perhaps it might not be. For those that don't know, Mayhems actually produces a lot of the coolant for Corsair's custom liquid-cooling product line, a market that has interestingly exploded over the last year alone (it seems that folks like tinkering with their rigs and building liquid-cooled loops in lockdown).

But could XTR make its way into the realms of AIOs? We can't say for sure, but tests have been carried out in Corsair's Hydro series AIOs with the custom coolant, and there's reportedly a marked improvement over the glycol-based solution that's used by most manufacturers.

XTR was actually designed and developed with small radiator cooling in mind. In these scenarios maximum thermal efficiency is far easier to reach than within a fully custom loop, and so moving heat away to the radiators as fast as possible is far more important. That said, AIOs provide some significant hurdles that need to be overcome if we're to see this transition occur. For one, AIOs use smaller pumps than fully custom-built loops, which could be a hindrance for XTR's tiny particles, and secondly it needs to be self-maintaining over many years, and not degrade. Testing is underway, but unsurprisingly it will take a while to see the results of that come to fruition. So it may be later in this decade that we see a transition over to more efficient AIOs, with superior coolant as well.

this process, but it will ensure sub-ambient temps for the processor in question.

Now immediately there's a few hurdles to overcome with this. Perhaps the biggest one is condensation. Because it's operating at sub-ambient temperatures, any moisture in the air is likely to condense on the processor. EK suggests that it's got around this by using an advanced form of integrated insulation that isolates all of the cold surfaces from any environmental conditions internally in the rig. On top of that, it's partnered with intel to develop specific software and firmware known as "Cryo Cooling Technology" to continually monitor and adapt the conditions to minimize any potential risk created through the use of the TEC.

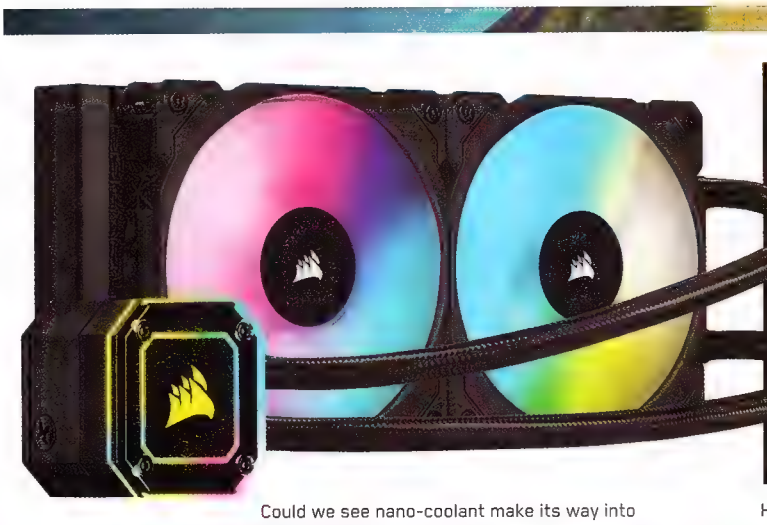
If this works well, it could be an incredible step towards sub-ambient cooling being a regular addition to high-end processors, and it's likely we'll see more of this tech from far more companies, with it even being integrated into the likes of AIO liquid coolers later in 2021 and 2022. Additionally, as it becomes more popular, its costs should decrease. As our power-draw requirements have plummeted over the years, there's plenty of headroom in a lot of systems to use that excess power to siphon off additional heat generated by the processors, both in GPUs and in CPUs.

One thing worth noting is that EK's QuantumX Delta TEC currently costs $599 for the block alone. But this is an exciting next step: If the technology becomes prominent, both Intel and AMD could start pushing their high-end chips to operate at expanded frequencies when paired with a TEC-like device such as this. We could see aftermarket variants pop up from the likes of Cooler Master, Corsair, and more, if it proves very successful.

Case fans

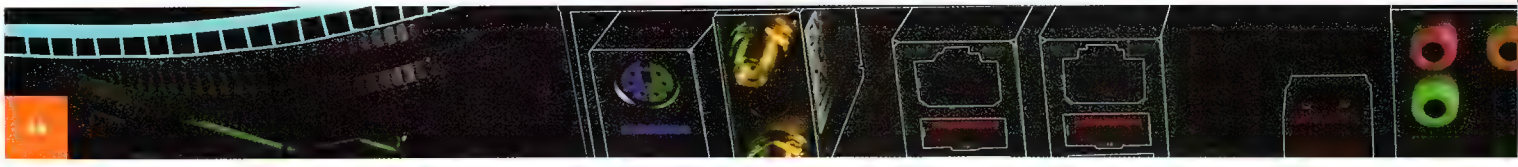
As for fans, things are more unknown, perhaps unsurprisingly given the nature of the market. Rumours abound that Noctua might finally be releasing a Chromax variant of its NF-F12 successor, the NF-A12. The A12, debuting back in 2019, featured a potent new motor design, and had tolerances of less than 0.5mm between the blades and the outside edge. Reconfiguring the materials to take advantage of the more common black colour has taken time, but it's likely to arrive this year. Its 2.34mmH2O static pressure and max airflow of 102,1m3/h at 22.6dB(A) make it one of the most powerful radiator fans on the market.

Another interesting product coming from the big beige company is its Fanless CPU cooler. Originally slated for launch in 2020, this behemoth of a passive aluminum air-tower (weighing in at 3.3lbs) is capable of cooling processors with a TDP of up to 120W guaranteed. However, in more confined environments, and with the assistance of a few internal case fans, that figure can rise to a staggering 180W of total heat output (even in both configurations, that's enough potency to cool an AMD Ryzen 9 5950X, or Intel's Core i9-10900K). The last we saw of this thing was at Computex 2019, where it managed to keep an Intel Core i9-9900K at 94C, while running a fully loaded instance of Prime95, all day long, in Taiwan's very balmy climate. Expect this to launch some time in Q1 2021.



Could we see nano-coolant make its way into Corsair's next-gen coolers?

HP's latest VR headset looks set to blow Oculus and HTC out of the water.



Corsair's ML120 Pros, revolutionary when first launched, are getting long in the tooth. With the launch of the most recent Capellix line of coolers, these AIOs came with a brand new fan iteration in the form of the ML RGB series. These are only minor updates, but currently the fans can only be bought included with the AIO itself, so expect to see these come to market around June.

PERIPHERALS PUSH FORWARD

FROM MICE AND HEADSETS TO VR AND BEYOND

2021 is shaping up to be another good year for PC peripherals, both in the professional and gaming sectors. A year of working from home has meant that more and more people need good home setups, from quality keyboards to comfortable headsets. 2020 has seen some awesome peripherals with brilliant innovations, from the adjustable actuation point of the switches on the SteelSeries Apex Pro to the widespread implementation of virtual 3D audio in gaming headsets.

So, what does 2021 hold? Let's start with a shiny new headset. Gaming audio expert HyperX has a new one in the works, the wireless Cloud II gaming headset. It packs a 30-hour battery life, 53mm neodymium drivers, and a 2.4GHz wireless connection for minimal audio latency. It also comes with HyperX's excellent noise-cancelling technology in the boom microphone, which is certified by both Discord and TeamSpeak (and us, for the record). Virtual 7.1 surround sound is an obvious inclusion too, all dressed up in the manufacturer's signature black and red, with plush leatherette and memory foam earcups.

We've got some new keyboards coming in too, such as the new Cherry MX-powered models of the awesome One 2 RGB and Mecha Mini v2 from Ducky, replacing previous Kailh-switch versions. Doubleshot PBT keycaps, awesome new switches, and a variety of unique designs make these a very enticing prospect for mechanical keyboard lovers.

In the VR arena, HP has a new model incoming: The Reverb G2. Initial impressions are good, with ergonomic cameras and tracking pairing up with dual 2,160 x 2,160 LCD panels at up to 90fps, for a VR experience that looks set to blow the competing Oculus Rift S and HTC Vive Pro out of the water. Steam functionality comes as standard here, as both the lenses and speakers of the G2 are designed by Valve itself. The speakers look pretty chunky, but sit 10mm off the ear to ensure comfort. It's also one of the lightest VR headsets around, with models starting at just 1.1lbs.

We'd place money on a new model of the HP "VR Backpack" too, a wearable PC designed to support the original Reverb. The previous backpack was a business-targeted product, equipped with an RTX 2080 and 32GB of high-speed RAM, so the notion that HP will be willing to send us a review unit is (perhaps!) us getting overexcited. In any case, there's plenty of tech we're looking forward to playing with this year. ■

The light fantastic

You heard it here first: Mechanical switches are dead, long live optical switches. These nifty key switches use light beams broken by depressed keys to register input.

This has a few different advantages over conventional mechanical switches. Obviously, the speed-of-light actuation is a boon for twitchy pro gamer types, but the difference in input registration is measured in milliseconds so won't be that noticeable to the average user. The most important benefit for the consumer is the improved lifespan and repairability; no physical electrical component means that optical switches last considerably longer than their mechanical counterparts, typically for 100 million keypresses or more.

Improvements for the consumer alone won't make a new type of product viable. But optical key switches are easier to design and implement, resulting in lower manufacturing costs and easier repairs. In the long run, optical keys will save manufacturers money – especially if it leads to fewer warranty claims – so it's not hard to see why the keyboard industry is likely to make the shift.

Of course, we're not actually calling time of death on mechanical keyboards. There's still a way to go in developing optical key switches that are better and cheaper to produce, and mechanical switches currently offer greater variety and moddability. Gateron has its own optical switch line, while peripheral manufacturers such as Razer and Asus ROG have developed their own proprietary switches, currently limited to purple clicky and linear red styles respectively.

Ducky's Mecha Mini was seriously impressive, and its v2 is expected to be even better.

Optical switches are without a doubt the future of affordable keyboards with a tactile feel.

FEATURE

The future of home networking

Chris Szewczyk explains the current state of play, and what's coming soon.

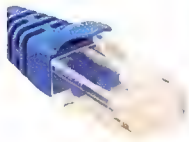
Some of our readers may remember the *Beyond 2000* TV show in the 80s and 90s. We remember seeing portable video calling devices and thinking they were something right out of *Star Trek*. Things like remote workplaces or gaming with someone on the other side of the world were sci-fi dreams. Others might remember downloading a song from Napster at a whopping 5KB/s, or perhaps you fondly recall interactions on MySpace. The march of technology, changes in our lifestyles and the way we interact with each other and share content continues to evolve. All this interconnected technology has created an insatiable need for faster and more reliable bandwidth and networking that will only continue to grow.

According to Cisco's annual *Internet Report*, there will be 29.3 billion networked devices by 2023, or 3.6 per person. The total annual internet traffic is expected to hit 4.8 zettabytes per year in 2022. That's a lot of DVDs (over one trillion). That means that governments and industry must continue to develop and build the infrastructures that are facilitating the changes in the way we relax, share, work and communicate.

Before we talk about the explosion of internet-enabled technologies, let's talk about the need for fast and reliable connectivity. The first thing you need to do is make sure your home has the right infrastructure, not just for now, but for the years to come too.

Ethernet

For now, and the medium term, the old faithful Ethernet connection, switches and cabling is a cheap, reliable, fast and low latency option for home applications. 2.5G Ethernet is slowly beginning to gain a foothold in the consumer space. With Ethernet, you don't have to worry about interference, coverage dark spots or unauthorised access. 5G and 10G connections have been around for some time, but for now they remain generally out of reach of the masses due to their expense and the problematic heat generation and power consumption of 5G and 10G controllers and switches. 10G is coming though. If you're building a home with an eye to the future, some Cat6a cabling and strategically placed ports throughout your home will leave you well set to take advantage of 10G in the coming years.



Above: The ubiquitous network cable is the old reliable way to get trouble-free networking performance in the home. Downside? It's a cable.

Above right: Motherboards featuring Intel's new Wi-Fi 6E AX210 controller are cutting edge, such as this Asus Strix Z590-E Gaming board.

One of the simplest things you can do to prepare a new home is to include cable conduits. This allows you to easily adapt as the technology demands. Building in appropriate conduits means you won't have to drill or cut through walls or floors, and you'll be able to install things like fiber or A/V cables if and when there is demand for them. Some forward thinking and a few bucks now for some tubing could save thousands in the long run.

Wall cavity cable conduits are great solutions for home networking, this CableClear kit from Bunnings is $58 for a 1m length.

Wi-Fi

Wi-Fi is a ubiquitous part of daily life and it's where the most rapid consumer networking advances are taking place. The advent of WiFi 6 or 802.11ax means that Wi-Fi technology is better and faster than ever, with more coverage, lower latency and multiple user support thanks to technologies such as MU-MIMO and OFDMA. Until now, Wi-Fi signals have been carried over 2.4GHz and 5GHz bands. The brand new Wi-Fi 6E standard adds coverage in the 6GHz range. This alone allows for even faster, lower latency connections. The wider spectrum allows for more simultaneous users. When used in combination with repeaters to create a mesh network, coverage is better than ever. The new Samsung S21 Ultra supports Wi-Fi 6E and many upcoming Intel Z590 motherboards and laptops will add the Intel Wi-Fi 6E AX210 controller. If you're building a Wi-Fi network with an eye on the future in 2021, Wi-Fi 6E is where it's at.

There are a few important considerations and a minefield of jargon to navigate when purchasing a Wi-Fi router. Wi-Fi 6 should be considered the baseline for a 2021 router purchase, at least before 6E products gain a foothold. The first thing you'll likely notice is the combined maximum speed of the router. Something like AX3000 (3000 Mbps) might look slow compared to AX11000 but these are the maximum theoretical speeds of all bands added together. Even combined at the same time, your devices will likely never see the maximum rated speed at once. The faster ratings are best suited to households with many actively connected devices that share data between each other more so than the internet. Bear in mind that your actual internet connection is a much greater bottleneck.

Some routers are very expensive. Are they worth the money? The cop out answer is it depends. Gaming routers are typically overhyped. They usually offer some useful traffic management (QoS or Quality of Service) features that can prioritise gaming traffic under heavy network loads but they won't magically improve your latency or ping times as the influence of the router ceases once your traffic hits the wider internet.

You'll also see reference to numbers like 2x2 or 4x4 MIMO. This refers to the number of spatial streams on a channel. For example, a 2x2 router can connect to up to two clients via two antennas. A 4x4 router can connect to four clients via four antennas and so on. Combinations such as a 1x1 plus a 2x2 are possible depending on the connecting device. Bear in mind that it's virtually impossible for several connected clients to saturate the streams at any given time.

If you have a large or multiple story house, you might want to look at a mesh Wi-Fi network, which makes use of repeaters to better cover troublesome dark spots. Another useful feature of modern routers is beamforming. In simple terms, the router projects signals towards a connected device in order to provide a stronger signal rather than just blasting it in all directions.

Many users receive a modem or router supplied by their service provider. In general they can be described as adequate at best. Older routers with 802.11g or n Wi-Fi are not able provide the multi user connectivity and security of a modern Wi-Fi 6 connection. Even 802.11ac (Wi-Fi 5) wave 1 products are not designed with many high bandwidth users in mind. 802.11ac Wave 2 products introduced MU-MIMO, four spatial streams and 160MHz channels, all of which greatly enhance multi device connectivity capabilities. So, if you are using an older, or ISP provided router and you're hearing

complaints in your house, ("my internet is so slow!") it maybe be the result of a Wi-Fi bottleneck, and not the internet connection itself.

Security is vital. Look for WPA2 encryption at a minimum. If your router only supports WPA encryption or, god forbid, WEP, then it's time for an upgrade.

Bluetooth

What about Bluetooth? Look out for that too. The Bluetooth SIG has big plans for its ecosystem, including smart home applications, mesh networking and mandatory security protocols. Bluetooth's strengths are its lower power consumption and its suitability for simpler or affordable devices that don't require the high bandwidth or range offered by Wi-Fi. Wi-Fi and Bluetooth can easily co-exist.

A premium router like the TP Link AX11000 is loaded up with eight antennas, allowing 4x4 MU MIMO support and can handle up to 12 simultaneous streams.

"Another useful feature of modern routers is beamforming. In simple terms, the router projects signals towards a connected device in order to provide a stronger signal rather than just blasting it in all directions."

2021: The year of 5G?

CES 2021 was full of 5G devices, including everything from phones and laptops to things like cars and drones. 5G can deliver data an order of magnitude faster than 4G with lower latency, which is enabling a new wave of connectivity and exciting applications. Things like teleconferencing, AR and VR, health and educational applications, car automation and infotainment are all poised to take advantage of 5G networking. Thanks to 5G, we should see a lot of amazing ideas come to fruition in the next few years.

5G is useful for so much more than just mobile though. Many homes in Australia suffer from slow or unreliable internet connections, particularly those in rural areas who were saddled with outdated wireless or satellite connections during the NBN rollout. Costs and data caps mean you probably wouldn't use your 5G connection to binge 10 seasons of a TV show, but it is a perfectly viable option for all kinds of applications that require a high bandwidth, stable, reliable internet connection.

You'll be able to share your 5G connection with others in your household too. Consider the Netgear Nighthawk M5 mobile router, which is equipped with Wi-Fi 6. It's also portable and can be used on the go thanks to its integrated battery. So if you're at home, out on the road or even need an emergency backup in case of NBN downtime, the Nighthawk M5 and others 5G routers like it are poised to take full advantage. Look out for a review of the Nighthawk M5 in APC when they go on sale in Australia.

Wi Fi 6 CERTIFIED

The networking standard formerly (and still, if you're geeky like us) known as 802.11ax, is the current vaguard of high-speed gear. Look for this logo on your new purchases.

Manage, protect and secure your data

Any discussion about networking and data should begin with the need for security and redundancy. The most important thing to emphasise is the need to protect your valuable data. Some sort of backup functionality or capability should be a part of every network. In the past, a family might have had a few photo albums. If your house was burning down and you had to choose a few items to save, those albums would be high on the list. Memories of your child's first steps or first day at school, a holiday, a graduation or wedding are priceless and irreplaceable. It cannot be emphasised enough, you must backup your precious data, and then back it up again on another medium or in the cloud.

Jargon buster

Wi-Fi 6E Allows connections in the 6GHz band that can double the bandwidth with half the latency of a comparable Wi-Fi 5 connection

1x1, 2x2, 4x4 etc- The number of antennas on a router which correlates with how many spatial streams it can send and receive at the same time.

WPA (Wi-Fi Protected Access) The current Wi-Fi security protocol (WPA3) provides better security than previous WPA standards. It is much more resistant to brute force attacks.

MU-MIMO (Multi-user Multiple-Input, Multiple-Output) a Wi-Fi technology for streaming high bandwidth content seamlessly among several users. It's complimented by OFDMA.

OFDMA (orthogonal frequency division multiple access) A key feature of Wi-Fi 6 that improves small packet data transmission to multiple devices at the same time.

Category 6A An Ethernet cable standard certified for 10G connections with a maximum length of 100 metres.

IoT (The Internet of Things) an umbrella term used to describe network connected devices that exchange data between other devices, the larger internet and the user.

A NAS (Network Attached Storage) is an underrated device and should be a part of any networked home. It's far more than an external HDD. In the home it can function as a central storage and streaming hub for all the devices in the home. It can be a backup device, a download server, a productivity tool and much much more. A NAS with two or four or more drives will feature RAID and redundancy, though solely relying on RAID as a backup is not recommended. Most NAS feature some kind of cloud connectivity or USB backup option, you should use these options to protect those aforementioned priceless files. It's easy to download 20 years' worth of *The Simpsons* again, but some data cannot be replaced. Take care of your data! Always!

That brings us to cloud storage. While uploading critical information such as your crypto currency wallet keys is not recommended, cloud storage is a fantastic option for many users, and you're probably doing it already, knowingly or not. That video you posted on Facebook is in the cloud. Dropbox, Google Drive, Microsoft OneDrive and many more are all perfectly viable options. Paid services tend to offer more features including collaboration or encryption and of course, more capacity.

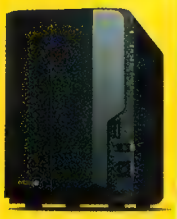
Streaming: The global bandwidth hog

Perhaps the first time a user notices a networking bottleneck is when it comes to streaming to two or more users. Streaming and sharing content among all users easily and on demand, even at 4K resolution is becoming a standard occurrence in a lot of households. Laptops, phones, tablets and PCs all need access to high speed internet and networking for HD and 4K streaming. Wi-Fi, which should incorporate MU-MIMO and OFDMA will help to facilitate this. Older Wi-Fi 802.11B, G and N is woefully inadequate to deal with modern demands. Netflix, YouTube, Foxtel GO and many others all require a stable connection in order to avoid stutters.

4K video has hardly gotten a foothold in the consumer space, yet 8K TVs have already been on sale for a couple of years. It might be some time before 8K becomes mainstream, but 8K content may be closer than you think. Japanese broadcaster NHK is scheduled to broadcast the 2021 Olympics in 8K. The PS5 and Xbox Series X can both render at 8K. Even some humble phones can record 8K content.

Sooner or later, once 8K TV's are present in enough homes, the likes of YouTube, Amazon and Netflix will introduce 8K streaming. That means you'll need more bandwidth from your internet connection and internal network. Lots more. If Mum, Dad and the kids all want to watch their own streams, your network will be put under serious strain. What if little Jimmy wants to join a game of *PUBG*? Your front door cam is recording? It all adds up. 8K content will become increasingly prevalent but it will be helped as new compression technologies continue to develop. VP9, HEVC and AV1 codecs reduce the bitrates required. Let's hope that the much maligned NBN network can handle the load in the coming years. Perhaps that's a story for another day.

The brand new Netgear Nighthawk M5 is a router that uses 5G, so it's a good solution for areas where standard NBN is worse than 5G network speeds, and is also a good solution to take on travels.



Even a cheap and basic NAS, like the Synology DS220+, offers foolproof backup for your network data.

IOT and smart home

Many of our tech savvy readers would have seen the term IoT, or Internet of Things. Big tech companies like to talk about their grand visions with displays of smart ecosystems, all connected to each other, sharing data and working together to aid in our lifestyles or streamline our workflows. It's not some abstract futuristic concept, but something that's real, and well and truly already part of many people's daily lives.

ACTIVITY	MINIMUM DOWNLOAD SPEED (MBPS)
GENERAL USAGE	
General Browsing and Email	1
Streaming Online Radio	Less than 0.5
VoIP Calls	Less than 0.5
Student	5 - 25
Telecommuting	5 - 25
File Downloading	10
Social Media	1
WATCHING VIDEO	
Streaming Standard Definition Video	3 - 4
Streaming High Definition (HD) Video	5 - 8
Streaming Ultra HD 4K Video	25
VIDEO CONFERENCING	
Standard Personal Video Call (e.g., Skype)	1
HD Personal Video Call (e.g., Skype)	1.5
HD Video Teleconferencing	6
GAMING	
Game Console Connecting to the Internet	3
Online Multiplayer	4

The Federal Communications Commission maintains a regularly updated estimate of bare-minimum speeds required for various activities. Bear in mind this is for a single user – families or shared households doing things simultaneously multiplies these figures, so take that into account when planning your NBN service.

Smart speakers are just the beginning, expect everything to run off your network, and soon.

Common implementations include things like home security and surveillance systems, home automation systems including lighting systems, temperature control, garden irrigation and things like pet feeders and coffee machines. These systems all rely on some kind of network connectivity, whether or not they require human interaction or direct remote control. The best systems will always consider energy efficiency and sustainability.

Many of our readers will have homes with Google Nest, Amazon Alexa or Apple HomeKit. They offer some interesting features but service be made obsolete if the company shuts down? Will 20 different smart devices require 20 different apps to manage? It's an evolving field. The genie is out of the bottle though, but ease of use and trust will remain central to adoption.

Cloud gaming

If PC use has slowed as we shift towards a more mobile lifestyle, gaming is certainly not the reason for it. PC gaming continues to drive the industry. A gaming PC isn't cheap though, and with shortages in graphics cards an ongoing issue, cloud gaming is something that's being talked about more and more,

"Another useful feature of modern routers is beamforming. In simple terms, the router projects signals towards a connected device in order to provide a stronger signal rather than just blasting it in all directions."

the really exciting stuff is yet to come. AI technologies will adapt to their owner's needs, robotics will help with common household tasks. Perhaps your fridge advise you if you have had one too many ice creams? The ideas and opportunities are quite limitless.

It's not all wide eyed wonder stuff just yet though. IoT and Smart Home technologies are a minefield of conflicting standards and proprietary technologies. Many consumers are attracted to plug and play solutions without really understanding how they truly work or the possibility of security vulnerabilities. Could someone else access your camera? Will a device connected to a cloud but is it practical?

Services such as Nvidia's GeForce Now, Amazon Luna and Google Stadia offer the ability to play demanding or AAA games on far less capable devices. It's a fantastic idea but hurdles remain. The problem is latency. It doesn't matter how fast your network or internet connection is, your real latency can only be as fast as the slowest link in the chain. As soon as you go outside your house, your connection and pings jump through a globally spanning network of hubs, routers and switches, all of which add latency. This makes cloud gaming unsuitable for fast past shooter games but well suited to things like turn based games or strategy games that don't require such precise inputs. If you aim for the head, you want to hit where it is, not where it was. This effect is compounded in multiplayer scenarios which often suffer from latency issues even with regular gaming PC's. Time will tell if cloud gaming becomes truly viable or not.

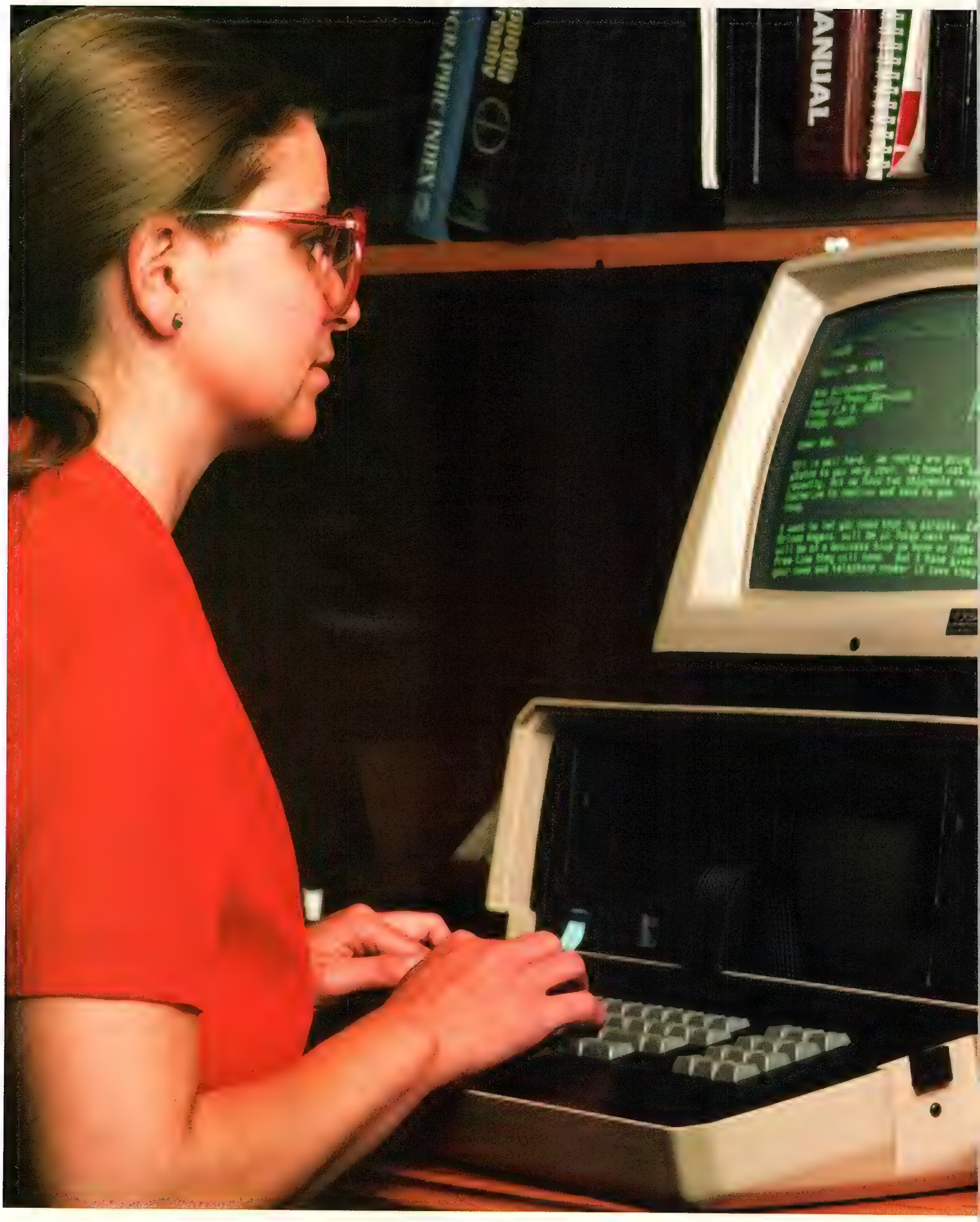
Sony and Microsoft also offer cloud gaming services. Some speculate that the current PS5 and Xbox Series X could be the last console generation as we know it. Let's see how things develop over the next five or so years. Calling the death of traditional consoles is definitely premature. Network latency is problem that will need to be solved first.

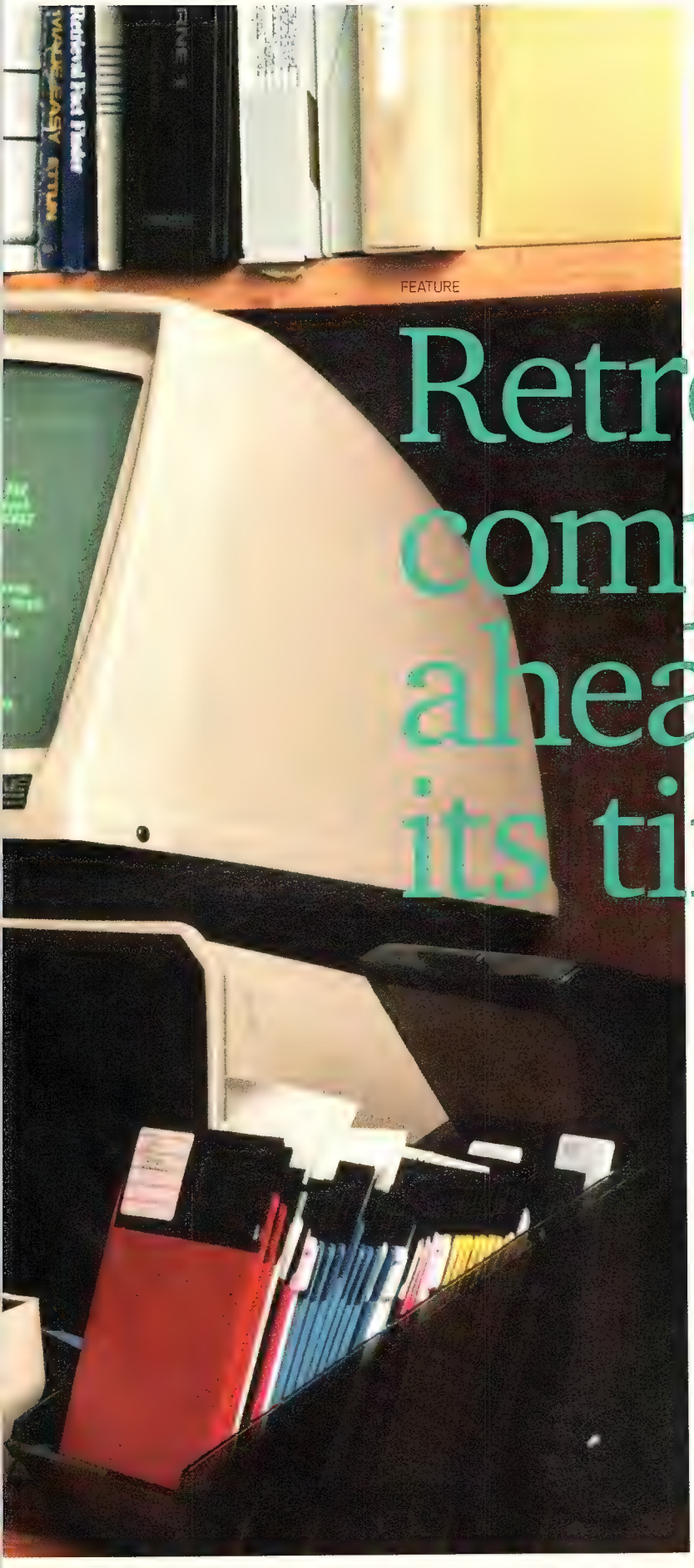
Conclusion

The numbers and types of devices that are networked continues to explode. More users with more devices are accessing more content at higher quality than ever before. Think PCs, laptops, phones, tablets, smart watches, smart TVs or DAB radios that all need internet connectivity. But that's just a part of the need for fast networking. What about a doorbell camera? A security and surveillance system connected to a NAS? A baby monitor? A coffee maker that automatically prepares your 7:00AM heart starter? You need to make sure your home has the right infrastructure for your needs, now and into the future. As much as it's possible to predict it anyway!

Entertainment and streaming is one thing, but when you think of things like cloud storage, online and cloud gaming and the burgeoning Internet of Things, then it's glaringly clear that our need for bandwidth and connectivity is insatiable and growing. What will it be like in five years, not to mention 10?

Whether your devices talk to each other from the next room, or across the world, the need for secure, reliable and scalable networking is paramount. With knowledge of how device functionality, connectivity and bandwidth requirements will continue to evolve, you'll be able to plan for your increasingly interconnected home. Let's hope the coming decade is an exciting one! If we survive it that is!


GRAPHIC INDEXES
ANUAL



FEATURE

Retro computing ahead of its time

John Knight looks at where we've come from, and where we're going.

Today, CPU speeds are measured in gigahertz. Our RAM size is measured in gigabytes. Our machines are thousands of times faster than when home computing started. It's easy to look at how far computing has progressed and be smug. But is it possible that we think we've progressed further than we really have?

Try watching old episodes of *The Computer Chronicles* or *The Computer Programme* (BBC, all on Youtube now) and it can be very surprising to see what they could do with technology of the past – computers that were thousands of times slower than what we have now, or just entirely different. From analogue and mechanical computing, to early inter-planetary digital photography; from early multimedia, to an internet before the internet – history is full of technological sophistication, largely driven by methodologies that have fallen out of favor.

Join us as we look back through computing history at accomplishments that seem almost impossible for the tech of the day. We'll look at computing before the modern digital age, 20th-century technology ahead of its time, and a special look at the most tech-mad decade of all: The 80s.

Ancient and not-so-ancient computing feats

Computing's distant past is full of incredible engineering feats, with computing accomplishments that boggle the 21st-century mind. Here's a small selection of computing feats that happened earlier than anyone would believe.

Ismail al-Jazari: ancient robotics

Considered by many as the father of robotics, Ismail al-Jazari (1136-1206) designed the first humanoid "automatons," and could also be considered as a sort of ancient open-source advocate.

In 1206 al-Jazari compiled his works into a tome dubbed *The Book of Knowledge of Ingenious Mechanical Devices*. Al-Jazari included meticulous diagrams on how his machines were constructed, and his book is often considered a DIY guide. While other inventors used obscure language, limiting their works to elite circles, al-Jazari used plain language that was accessible to a wider audience in the hope that others would continue his work.

Al-Jazari's inventions were centuries ahead of European science and an inspiration to Leonardo da Vinci. Many of his creations still exist in some form today, and his inventions of camshafts and general methods for converting between horizontal and rotational movement formed the basis of the industrial revolution.

Of particular interest to scientific historians are his musical robot band and the Castle Clock. His robot band was a boat with four water-powered automatons, built to entertain guests at royal parties. Of particular note is the drummer, which was a programmable drum machine driven by pegs on cams. Rhythms could be pre-programmed by moving the positions of the pegs, which would in turn strike levers that operated the percussion. Apart from being a programmable drum machine – presumably the world's first – it's also considered to be the first programmable robot.

As for the Castle Clock, this was a highly intricate device that not only kept time, but would also keep track of zodiac placements, plus solar and lunar orbits. Other features included different mannequins that would appear at hourly intervals, as well as mechanised falcons that would drop balls into vases.

Of particular note to techno-historians is its ability to reprogram the length of days, in order to account for seasonal changes. This makes it the earliest known programmable analogue computer.

Lord Kelvin: analogue computing's heyday

In 1872 British mathematical physicist Sir William Thomson (1824-1907, later known as Lord Kelvin – yes, that Kelvin!) developed a tide machine, something that would go on to be foundational to the field of analog computing in the first half of the 20th century.

Tide prediction had existed for a couple of centuries, starting with Isaac Newton's theories of the Sun and Moon's effects on Earth's tides, and advanced by Pierre-Simon Laplace in the 1770s, and George Darwin in the 1860s.

However, the formulae and methods were phenomenally complex undertakings, calculated manually by humans, making tidal prediction a complicated and highly error-prone undertaking. This state of affairs would not do for Sir Thomson, who was known as a master of measurement and a prolific inventor.

Using an elaborate system of pulleys and wires, Thomson's machine was able to automatically predict tide levels for a particular location at a set time. Larger, more advanced machines were made in the years to come, and variants were made by the US and Germany, all of which was strategically vital during World War I.

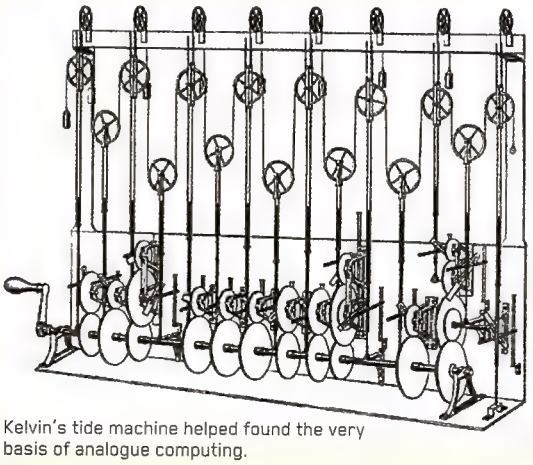
Thomson's work continued in the field, where he built a harmonic analyser in 1876, which used an assembly of discs to sum trigonometric series. Thomson noted that a similar device would be able to solve differential equations.

One of around 30 Thomson tide-prediction machines is on display and in full working order at the National Oceanography Centre, Liverpool, UK. Built in 1929, the machine helped to predict the tides for the Allied landings in Normany in 1944.

Charles Babbage: mechanical computing & steampunk digital

So far we've looked at analogue computers, which are extremely different to today's digital computers. For the origins of digital computing, history books usually start with Charles Babbage (1791-1871).

Starting with the Difference Engine in 1832, Babbage created a crank-driven mechanical computer that displayed digits on rotating dials. If you're thinking, "So it's an



Kelvin's tide machine helped found the very basis of analogue computing.

The Normandy landings wouldn't have been possible without the help of Kelvin's tide machine.

old calculator, big deal," this was far beyond what your pocket Casio can do. This machine could solve complex equations, follow numeric sequences, and even extract the root of a quadratic equation. The Difference Engine is historically interesting from a programming perspective because it could be programmed to display a specified number when triggered by another number.

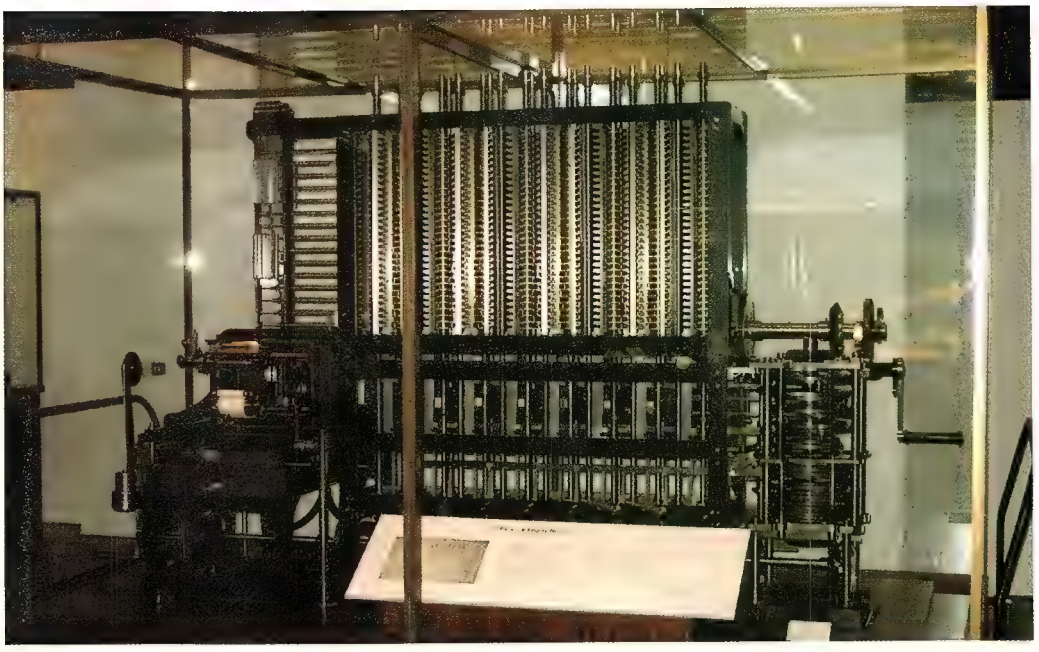
However, this was only a prototype, and the full engine needed to be built. Although Babbage managed to raise initial funding for the project, constantly changing design goals and a falling out with his engineers meant that the British government withdrew funding, and it was never completed. Babbage was cruelly mocked nationally.

The Difference Engine was a milestone in computing history regardless of its fate. However, it still wasn't really what we would call a digital computer. This was only a mechanical computer. For the genesis of digital computing we need to look at the Analytical Engine.

To be clear, the Analytical Engine was only designed, not constructed. But looking at Babbage's design is almost scary: It had punch card programming, 16.2 kilobytes of storage, something similar to a CPU called "The Mill", and even a programming language like Assembly.

In short, the Analytical Engine had the basic components of modern computing, with similar specifications to a mid-20th century mainframe, albeit quite a bit slower and also probably even more gigantic!

Given that the Analytical Engine was never built it would be easy to dismiss the project as a flight of fancy, but modern analysis reveals that the machine would have worked.



Babbage's Difference Engine was utterly incredible.

Al Jazari's Castle Clock was a thing of beauty.

Enough design existed at least for Babbage's friend Ada Lovelace to write a theoretical algorithm for the machine, for which history generally credits Lovelace as the first programmer. And yes, the first programmer – in the digital sense of the term – was indeed female.

If only the UK had stuck by Babbage, and if only Babbage had the humility to listen to his paymasters' concerns, then the world could have had a computing revolution a century early.

Early digital transmission from outer space

Although it isn't common knowledge in the West, Soviet space programs in the 1970s managed to land probes on Venus, sending back digital photos from the surface of our nearest planetary neighbour.

Starting in the 1960s and ending in the 1980s, the Venera program (Russian for Venus) became Russia's focus after a series of Mars probes experienced high rates of failure. With Venus being closer to Earth than Mars, it was felt by the Soviets that that planet could be reached and explored more reliably.

Even though Venus is closer to Earth than Mars, the planet posed its own challenges to the Russians, requiring probes that could withstand extreme heat and atmospheric pressure long enough to send back surface data to Earth.

The Soviets sent 16 probes in all, gathering useful information, such as telemetry data, chemical compositions, and temperature readings, but it was with Venera 9 and 10 that they were finally able to take photos of the surface.

These spacecraft were significantly strengthened over earlier probes in order to survive the hellish temperatures (around 460° C) and crushing Venus atmosphere, 92 times the pressure of Earth. The probes were sent to opposite sides of the planet, transmitting data by radio waves for around 50 minutes before burning up in the Venusian heat.

The images were only black and white and low resolution by today's standards – only 512 wide x 115 high. But this was early digital photography nonetheless, and image reconstruction techniques in future years were able to bring impressively sharp images.

In 1982, the Soviets returned to Venus with Venera 13 and 14, sending back higher resolution images (1024 x 252) in colour. They also sent back the first audio recordings of Venus, with the intention of measuring wind speeds.

All of this data managed to paint a fuller picture of a Venusian landscape: Endless deserts of black rock sprawled out under a yellow sky, while 358kph winds raced across in a carbon dioxide atmosphere, smothered in clouds of sulfuric acid. Brutal but fascinating.

Analogue computing?

Although analogue computers were poised to be the future of the 1950s the computing world has switched to a digital mode.

Unlike their digital counterparts, analogue computers use physical means to make calculations, such as dials, rings, sliding rules or mechanisms. Readouts are usually on dials or gauges. As such, one needs to allow for physical tolerances and a certain amount of error correction, meaning that analogue computers can't be relied on to return the same precise values repeatedly.

But analogue computing will never really disappear. If you've ever used a slide rule then you've used a simple form of analogue computing, and hybrid analogue-digital systems are still used in areas like aircraft navigation.

A big advantage of analogue computing is that it can sidestep the digital world's need for computing power, as long as someone can design a system that...

Back to the Future: The Tech-Crazed 80s

The 80s: A time when computers and video games finally became household items, and people went gadget mad. We laugh at some of these now, but as you will see, some of the technology was way ahead of its time. We'll also throw in a little of the 90s too!

Graphics, video, and sound: Atari and Commodore's advanced multimedia

In 1985 computing experienced a sudden jump forward with two 16-bit machines: The Atari ST, and the Commodore Amiga. Bear in mind that the Commodore 64 – the king of the 8-bits – had only been around for a couple of years before these next-generation machines arrived!

Based on the Motorola 68000 CPU, these new computers used a processor that until then was mostly used in expensive industry workstations and arcade machines. There was of course Apple's original Macintosh (1984), but this was very small, black and white, limited in its multimedia capabilities, and very expensive. In comparison, the Atari and the Amiga were reasonably priced and incredibly powerful for the money.

Where Commodore's strategy was to fit dedicated hardware for sophisticated graphics and audio, Atari opted for brute force by using a faster CPU and fitting twice the RAM as the Amiga, while substantially undercutting Commodore on price.

While the established 8-bit microcomputers and IBM-compatible PCs were still grounded either in DOS or BASIC, these new machines were hardware-optimised to use a desktop – unlike the existing micros and PCs that lost substantial performance when faced with a graphical environment. These machines provided powerful graphics and sound when PC equivalents were primitive or expensive. People who'd never owned a computer before – especially creative types – were now taking a look.

Multimedia finds its niche

Both machines were famous for their multimedia capabilities: The Atari for its music sequencing, and the Amiga for its graphics and video processing, though there is plenty of great multimedia software on both machines.

Even though the ST had a cheap and nasty sound chip, Atari had the inspired idea of installing MIDI ports as standard – something that only cost 75 cents per machine but established Atari's niche in the music world.

Plugged into external MIDI equipment, the ST truly shined, with an excellent graphical interface and better latency than a lot of pro equipment. Programs like Cubase started on the ST, and its MIDI functionality are still used by top musicians.

As for the Amiga, audiences were wowed by drawing utilities such as Deluxe Draw, which had animation capabilities that became the industry standard in gaming, most notably by Lucas Arts with its *Monkey Island* series.

Deluxe Video created slideshows long before PowerPoint, and were the height of sophistication in office presentations. Disney had its own software suite that allowed rapidly produced animations.

The 1990's Video Toaster used the Amiga's ability to sync with video timing to create a video-effects suite that rivaled the machines of television stations costing more than $100,000.

Both computers had a decent gaming scene, but the Amiga's dedicated graphics and audio made it a natural fit for the multimedia demo scene that is still active today, where coders would continually search for new hardware exploits in order to make the most spectacular presentations.

The non AZERTY Minitel TELIC-1 launched in 1985.

The Amiga won out over the Atari ST, with better gaming and multimedia, but the ST had its own victories with musicians and office workers.

What about today?

Despite being decades out of manufacture, both machines are still popular and survive in some form, with very active communities. With the MIDI standard being so universal, an Atari ST should still be able to be used with much of today's musical hardware, and is used by the likes of Fat Boy Slim.

The Amiga also lives on through FPGA recreations and archives. If you want to use an Amiga desktop and apps on modern hardware, the open-source project AROS ports AmigaOS to x86 platforms, PowerPC, and the Raspberry Pi.

The Minitel: the internet before the internet

In the 1970s, the French government decided to radically overhaul its telecommunications network. France's telephone network was considered the worst in the industrialised world. Meanwhile, French offices were filling up with American-branded computers and software bundles.

Recognising a potential crisis, French president Valéry Giscard d'Estaing acted on a report "*The Computerisation of Society*", by Simon Nora and Alain Minc. Given that the phone network already needed overhauling, the government saw the chance to put France at the head of the computing revolution by layering computerised services over its new phone network. This would be accessed by a standardised terminal. First and foremost, this terminal would act as a replacement for the traditional telephone directory, but the government also saw the potential for monetised services.

Work began in 1978, and the first experimental models were rolled out in 1980. Dubbed the Minitel, early models were freely available, with a nine-inch CRT monochrome display and AZERTY keyboard.

Minitel machines were mostly dumb terminals that could use text-block characters to create rudimentary graphics. Rather than acting as independent computers, the machines were really powered by dialing into a PAVI: A Point d'Accès Vidéotexte – or videotext access point in English.

The Minitel takes off

While other nations had installed similar services, such as Ceefax in the UK or Telidon in Canada, these were never exactly mainstream. In France, however, the Minitel would quickly become a national phenomenon.

The Minitel was very simple to operate, and users found its phone directory service much faster than navigating a phone book. Customers were treated to mail and chat services a decade before these were commonplace via the web.

Colourful advertisements showed how users could do banking, buy cinema tickets, or even book a holiday, and French consumers adopted the machines en masse. At its peak, the Minitel had over 26,000 services available.

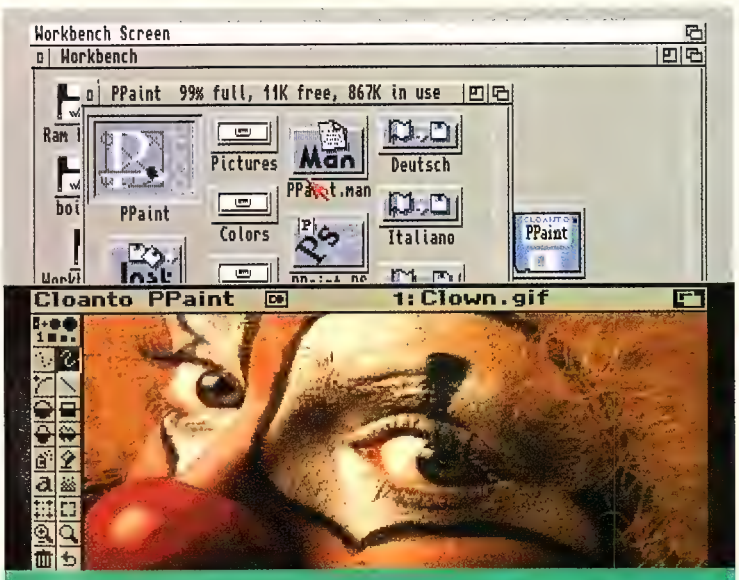
Where we now think of websites in terms of .com domains, street billboards would advertise Minitel services with a famous 3615 dial prefix, such as 3615 FOOT for soccer news.

In true internet style, the Minitel system had online dating and a myriad of adult chat rooms. It was also popular for downloading public domain software: It was cheaper than connecting to bulletin board systems, or even the early World Wide Web, and faster than waiting for floppies in the mail.

Students organised protest movements through the Minitel in a similar way to how social media is often used now. And much like today's services that assume you have some kind of social media account or email address, eventually the only possible way to enrol in university was via Minitel.

The Minitel was eventually overtaken by the World Wide Web, but there was a long period in France where certain services were still only available by Minitel, until these were eventually migrated to the web. During the transitory period, some services may have had an official website, but required booking or enrolment through the Minitel.

The Minitel was an incredible success, with over 9 million units in use during the 90s, generating 832 million Euros in 1998, and was still making 30 million Euros in 2010. 810,000 terminals were still used when the service was canceled in June 2012.



Virtual desktops

Amiga Workbench had two ways of navigating between desktops. The first was with keyboard shortcuts, where you could drop back to the main workbench and launch more apps. But it was the second method that is truly uncanny.

Amigas could "screen drag" by holding down the Amiga button while clicking and dragging the mouse. Whatever screen was on display would be pulled down to reveal whatever desktop or app was behind it. A button called a "depth gadget" could put desktops or apps ahead or behind each other.

This looks cool now, but was absolute witchcraft in the 80s, and looks amazing when multi-tasking with full-screen video. And, due to a hardware quirk, the Amiga didn't care what resolution each app used, and could switch between them at will – something not even modern computers can do.

Unlike today's web, privacy around user data was heavily guarded.

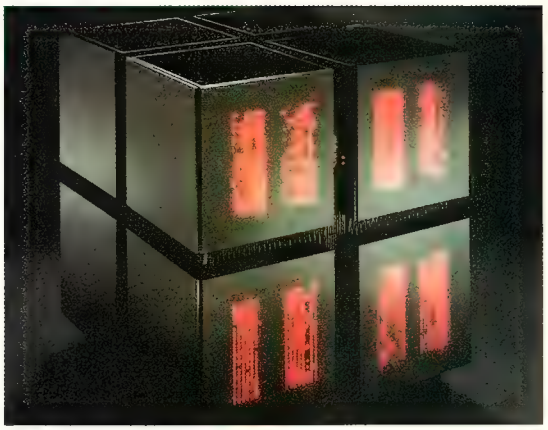
Where are we now?

So, are we suggesting that things were better back in the day, and that all of today's computing power and progress has been for nothing? Well no, that would be ridiculous. But although our machines are now many thousands of times faster, we don't have thousands of times the results – certainly not the kind of results we would have predicted in earlier decades.

Compare the last 10 years with the 80s. In two years we went from the Commodore 64 to the Amiga – an entire generational jump, involving machines at the top of their game. In the same year the PC went 32-bit with the 386. They started the decade with kilobytes of RAM, and ended it instead with megabytes.

We like to laugh at movies' predictions from the 80s and 90s, where everyone would have flying cars by now, and virtual reality had replaced the keyboard and mouse. But if you look at the astonishing rate of technological progress during those decades – and assuming that the same rate of progress would continue – then those predictions would have been quite rational. In many ways progress has slowed down. Changes are now evolutionary rather than revolutionary.

In the 80s, a few years between games would result in tangibly different results, and the difference between 1980 and 1990 was enormous. But compare games from 2010 and 2020, and they aren't radically different experiences.



Designer Tamiko Thiel's Connection Machine line would be a key influence on Steve Jobs and kick-start sales in supercomputers.

We use enormous operating systems to achieve tasks that are largely similar to those of the 80s and 90s. But where modern computers are a noisy mess of pop-up warnings, updates, and error messages, older computing is often simpler and quieter, with fewer distractions.

Sometimes it's quicker and more responsive too. Competition gamers often use PS/2 peripherals – a standard from 1987 – or old consoles with CRT televisions, especially with *Tetris* and *Street Fighter II*. Reactions count, and USB and HDMI have lag.

So what has gone wrong?

A big difference between then and now is the luxury of raw computing power – it seems that any problem can be solved by throwing more RAM and CPU cycles at it. This has resulted in very high-level programming, where programming used to be much closer to the metal.

On the one hand, this extra computing power has brought programming to the masses – there's even a growing no-code movement – but on the other hand, our code has become wasteful and inelegant, requiring enormous resources for even basic tasks. A modern web browser consumes a gigabyte of RAM even if a website is only kilobytes in size!

What we can learn?

Be careful with the word "obsolete." Newer doesn't necessarily mean better, nor more advanced. You may have the latest hardware, but does that necessarily make it fit for purpose? Could an older kind of technology achieve better results than what you're using now?

Computing history contains many brilliant technologies that have been lost along the way, but if today's engineers are willing to explore methodologies or form factors that have fallen out of favor, it may enable current technologies to make sudden leaps forward.

IT departments may also consider hiring older programmers and engineers to optimise code and bring different perspectives. What may take a team of younger coders a day in a visual-programming environment may be solved in two minutes by a Unix veteran with a terminal.

Older programmers may also be able to take code in very high-level languages and re-apply the algorithms in a lower-level language like C, or maybe even Assembly! Likewise, older engineering methods could provide simple and effective solutions to problems flummoxing younger engineers, who may only have been exposed to current technology. ■

Raspberry Pi to the rescue

Raspberry Pi founder Eben Upton started the project after seeing an alarming drop in coding proficiency with university applicants. With an extremely cheap machine, it was the foundation's intention to get children coding again, the way 8-bit microcomputers started bedroom coding in the 80s.

The default Raspberry Pi OS comes loaded with programming languages, environments, and interpreters, though there has always been a focus on Python - perhaps the best modern equivalent of BASIC. GPIO pins are displayed, making the machines perfect for hardware hacking.

The Raspberry Pi 400 has been hailed as a revolutionary new keyboard computer, when it's actually a return to the microcomputer form factor.

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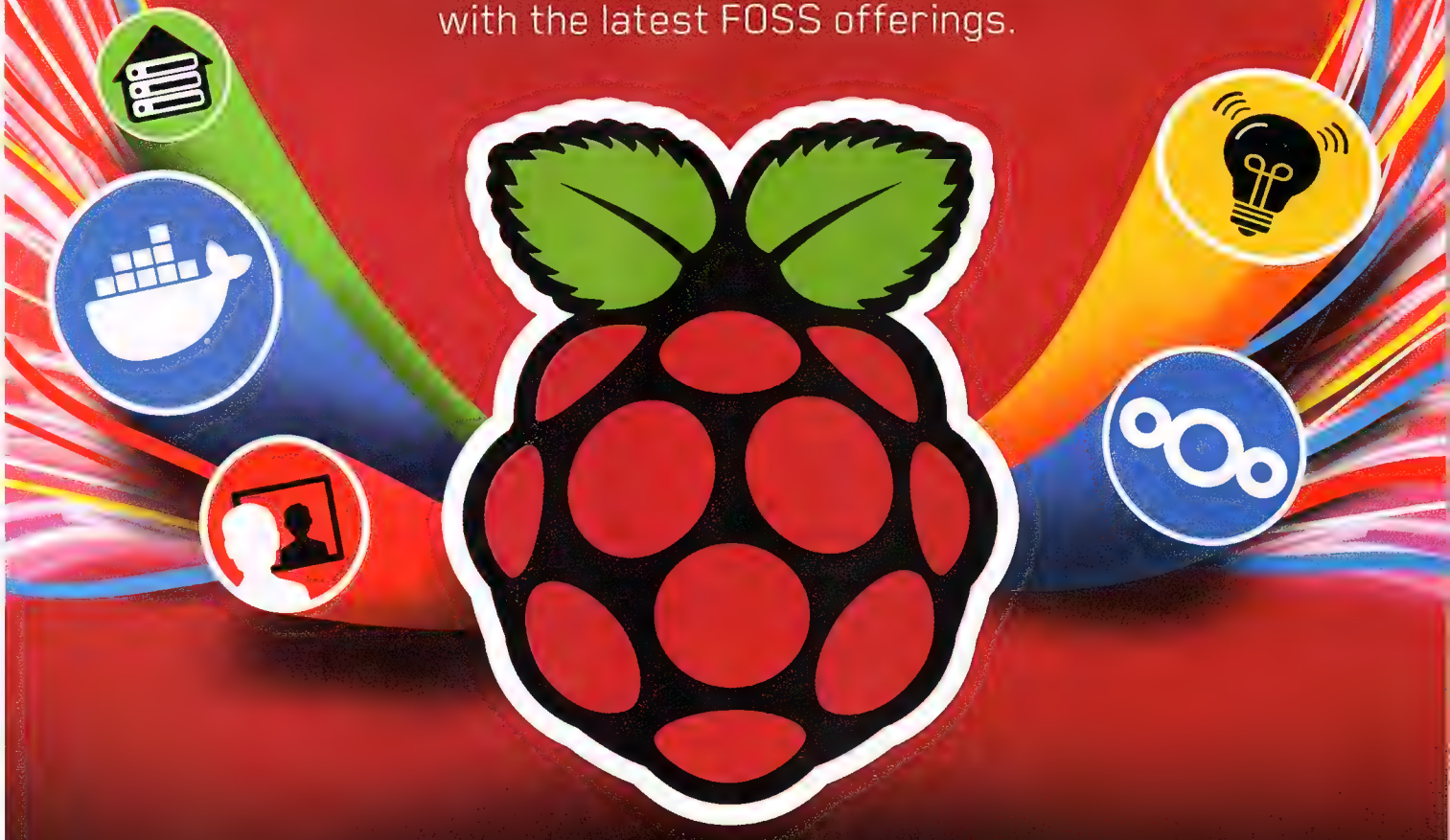
Build a Linux smart home office

Wiseguy Jonni Bidwell has some tips on making our homes and home offices smarter, with the latest FOSS offerings.



Creative ingenuity and the ability to cram a network stack into the smallest of things have gifted us, over the past few years, some pretty cool home innovations. Legacy (classical?) home dwellers may see little merit in upgrading to a smart home, but we have some uniquely Linux ideas that may persuade them.

Having a smart home needn't mean having Alexa (the voice of Amazon's Echo) eavesdropping on your every word. Nor does it mean the nameless entity within a Google Assistant reporting back to the mothership whenever you leave the bathroom light on. The Mycroft home assistant can do all the good bits of these voice devices, but without the more chilling data-collection aspects. Best of all, you can run Mycroft on a Raspberry Pi.

But there's more to smart homes than shouting at small robots. As summer makes its way across the land, good citizens will be collectively donning short shorts and firing up their fans and air conditioners. Some may find themselves having to shoulder the expense of a new cooling machine ; others will want to see if their current one can be hacked and tweaked to make for a more economical summers. Through the magic of OpenHAB, we'll show you how.

For many of us, the pandemic has seen our homes become unwitting extensions of the workplace, and depending on your line of work that may be the case for some months to come. So we've got a couple of projects for smartening your home office setup, too. Rescue yourself from Zoom meetings and banish Google's office suite with the open-source powerhouses Jitsi Meet and Collabora Online. And since Docker is all the rage, we'll look at how we can harness its power better using the Portainer management engine. This will make it easy for you to add any service you can imagine to your self-hosted smart home office, so let's get started!

A smart home office?

Take a look at some great tools that can make a smart home smart, and a home office, er, official.

To the cynic, all this new smartification of everyday items seems to involve putting networked computers in places where they're not needed, and needing dozens of companion apps on your smartphone to keep tabs on all these smart things – and in so doing, opening all these devices (and possibly your phone too) up to attack.

Some manufacturers are better than others at keeping their IoT things secured, and many attacks could be prevented by users changing default credentials. Since 2016, Raspberry Pis no longer ship with the SSH service enabled because it's too easy to spot them when they're exposed to the internet.

Watch this!

But there's a lot of smarthome projects that are fun, safe, and will bring some degree of joy to your home. Lots of these are variations on standard Pi maker projects – we really like, for example, Elio Struyf's project documented at **www.eliostruyf.com/diy-building-busy-light-show-microsoft-teams-presence**. This uses an LED array as a status indicator for outside your home office.

The pandemic has gotten lots of us quite used to video-conferencing, and with that comes the terrible fear of children (or grown-up children) interrupting your work chatter. Perhaps a brightly coloured warning light, which in this case hooks in to your Microsoft Teams account (it could be adapted to other services) to show that your status is "busy" will reduce interruptions?

Home security systems are all the rage too. Again, the Raspberry Pi is excellent at this – you could adapt our motionEye tutorial from page 98 to set this up, rather than going with an off-the-shelf product: Besides security concerns, such products could at any point stop being supported by the manufacturer, which effectively makes them useless. This very thing happened when Google bought Nest back in 2014. Then last year Google announced it was shutting down the Works With Nest program, effectively bricking all the legacy Nest hardware that wasn't produced by Google.

In theory this could happen with open-source projects too, but if it does, then at least the code is all there for someone else to take over the reins.

Hot smart stuff

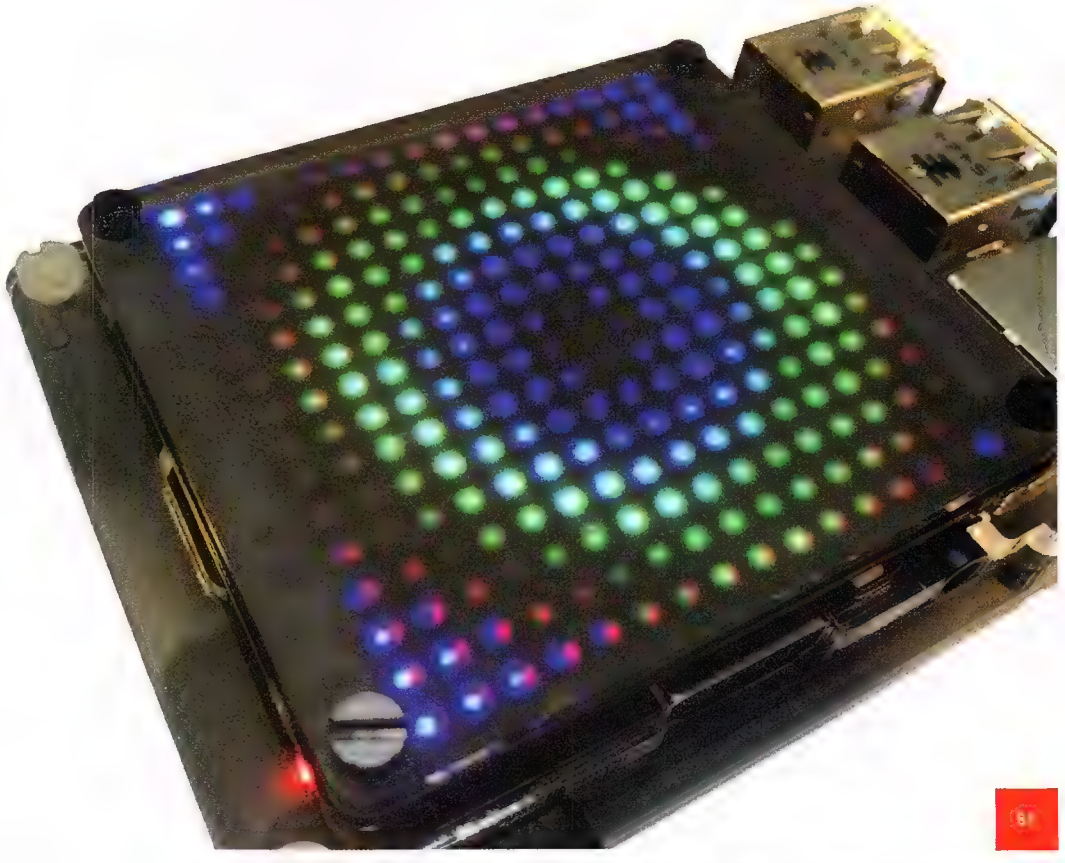
Utility companies are keen for everyone to have smart meters now, and these go in tandem with smart boilers, smart thermostats, smart fridges. In theory these can save you money, and it's certainly satisfying being able to pre-warm your house as you travel home.

We'll show you how you can connect all of these together through openHAB, the open-source Home Automation Bus. No smarthome would be complete without a voice assistant, so we'll revisit our old friend Mycroft over the page too.

We're also embracing Docker this issue, so we'll look at using that to smarten up your home office setup, using the Nextcloud cloud-productivity suite. Then we've got some tips on containing this container overload with Portainer, a management engine.

We'll also show you how to set up your very own video-conferencing service with Jitsi Meet. It's going to be an action-packed few pages, so get yourself a cup of coffee and enjoy!

"There's a lot of smarthome projects that are fun, safe, and will bring some degree of joy to your home.



The Unicorn HD, with its 256 RGB LEDs and Python interface, could make an excellent warning light.

OpenHAB and Mycroft

Use the power of Ubuntu's openHAB appliance and the Mycroft Voice Assistant to voice-enable your home.

The open Home Automation Bus, (openHAB) can connect all the diverse IoT appliances that may or may not be beginning to proliferate around your home. Typically these devices all have their own, often proprietary applications, but under the hood they usually use-open source protocols – and when they don't, people have figured them out enough to plug them into openHAB. We're going to do it a little differently to how we would before, because Canonical recently released the openHAB Ubuntu Appliance for the Raspberry Pi. This means we can write the SD card image, boot it and have a fully functional web-based home automation server.

In order to use these Ubuntu Appliances (there are currently four others besides openHAB, and more are on the way), you'll need to sign up for Ubuntu SSO (Single Sign On) at **https://login.ubuntu.com**. It's free, and you can use it all over the Ubuntu web ecosystem. Once you've done this you'll want to generate an SSH keypair and upload the public key, so that you can use your SSH-reinforced SSO to log in to your appliance. You may already have generated an SSH key, in which case you probably don't want to overwrite it. Check by running

```
$ ls ~/.ssh/id_rsa.pub
```

If no such file exists, generate it with

```
$ ssh-keygen -t rsa
```

and press "Enter" to accept the default location. Once the key is generated, run `cat ~/.ssh/id_rsa.pub` and copy the contents to the clipboard. Log into Ubuntu SSO and, go to the SSH keys section. Paste the contents into the Public SSH Key box and hit the import button. You can now SSH into Ubuntu services and appliances (from this machine only) using this key. But you still need to log your appliance into Ubuntu's cloud to fetch it, so follow the three steps below and do that.

Once setup is complete, take a note of your Pi's IP address and connect to it from a browser by entering, for example, **http://192.168.0.2:8080**. The openHAB interface can be a little confusing at first, especially given that the first step is "choose an interface." You can always return to this index page to explore the others. Choose PaperUI and peruse what Bindings (in the "Add-ons" section) are available, and if any of them match your hardware.

From here, your best friend is the openHAB documentation at **www.openhab.org/docs**. You can customise your appliance however you like. It's running Ubuntu Core so you can add Snaps from the repos. Instead of following our later section on Nextcloud, you can get a working install by SSHing into the appliance (the username is the first part of your Ubuntu SSO email) and running:

```
$ snap install nextcloud
```

Visit the Snapcraft store (**https://snapcraft.io**) and let us know how you augmented your appliance. Oh and do check out the others: currently Plex, Nextcloud, Mosquitto, and AdGuard have

*"In order to use these Ubuntu Appliances, you'll need to sign up for Ubuntu SSO (Single Sign On) at **https://login.ubuntu.com**. It's free, and you can use it all over the Ubuntu web ecosystem."*

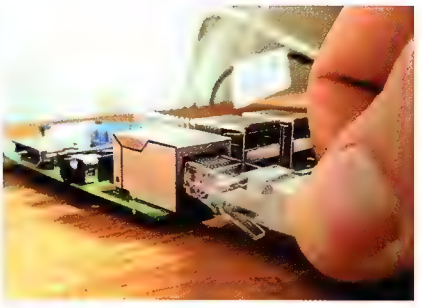
HOW TO Install openHAB

01 DOWNLOAD

Visit **https://bit.ly/MPCjanHAB** and download the image. It's about 500MB, but compressed. You'll need to decompress it with `xz -d openhab-core18-pi.img.xz` if you're going to write it out manually with dd in the next step, but the official Raspberry Pi Imager program can do this for you.

02 WRITE THE IMAGE TO SD CARD

At least a 4GB card will be required, and possibly more if you go all out with extensions. On a Debian-based distro (including Ubuntu) you can download the Pi Imager from **https://downloads.raspberrypi.org/imager** and install it with dpkg -i or graphically with Gdebi. Use this to write out the image file.



03 BOOT YOUR PI

Connect a monitor, keyboard, and network cable (optional) to your Pi, insert the freshly minted card, and fire it up. You will see some configuration choices and eventually will be asked for your Ubuntu cloud email address (see above) so that the appliance can be authenticated against your SSH keys.

been applianced, and more will surely follow.

You probably already know that Sherlock Holmes had an older brother called Mycroft – and that's where Mycroft Home Assistant gets its name. The Mark I device was a friendly, ET-looking voice assistant that was powered by a Raspberry Pi 3. We were big fans, but sadly that device is no longer available, and its successor has not yet been released. But that's fine, because Mycroft's brains are open source and can run on a Pi 3 or 4.

Buster rhyme

It's based on the official Raspberry Pi Linux Buster image, and you can download it from **https://github.com/MycroftAI/enclosure-picroft**. Use the Raspberry Pi Imager again (or something else if you like) to write the image to an SD card. This time you'll need at least an 8GB card. When it's done, put the SD card into the Pi and fire it up. As with the openHAB appliance, you'll need a display and keyboard connected to the Pi to run the initial setup, but afterwards these will not be needed unless something goes wrong. On first boot Picroft will resise its partition to use all available space on the SD card. When it finishes booting a second time, it will ask if you would like some help setting up your system, which you may as well accept.

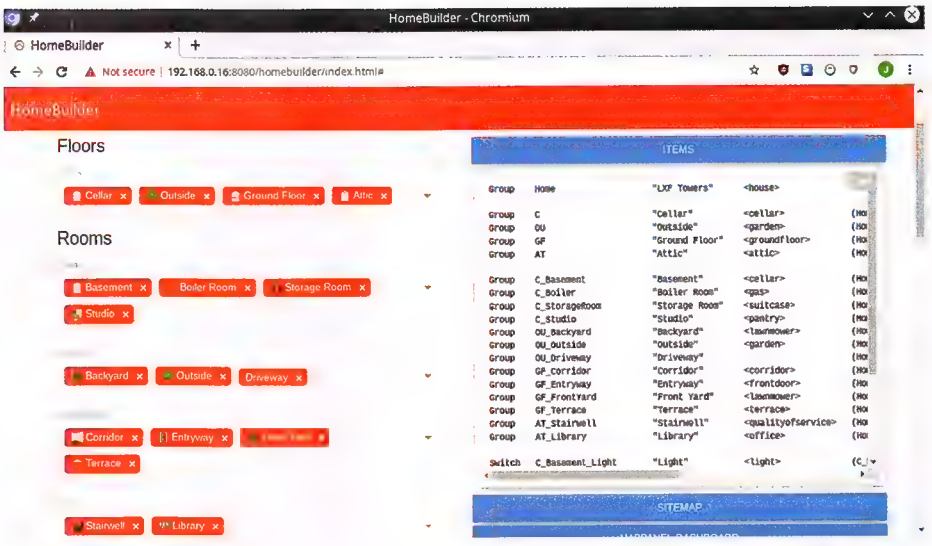
You'll need a microphone and speakers, and there's a list of supported hardware at the Mycroft wiki (**https://bit.ly/MPCjanPicroft**). Some of this will work out of the box, but some devices will need manual intervention.

We used a Seeed ReSpeaker 4-microphone array HAT, which was easy to set up. Other devices will follow a similar pattern. Just run:

```
$ git clone https://github.com/respeaker/seeed-voicecard.git
$ cd seeed-voicecard
$ sudo ./install.sh
```

If your network works (reboot if it doesn't) you can also SSH into the Pi to do this (default username "mycroft" with password "pi," which you should change).

Then, if you're using the 3.5mm jack for audio, you may need to run `sudo raspi-config` , select "7. Advanced Options," "A4 Audio," and finally "1. Force 3.5mm jack." Now reboot to enact the changes. If you run into difficulties with the ReSpeaker (or other Seeed models), the driver documentation is at **https://github.com/respeaker/seeed-voicecard**.



The HomeBuilder UI allows you to build your own virtual locations.

Reboot, and you can pair your device to the Mycroft Home service. You need to set up an account here to use the software, but hey, at least it's not Facebook. Only your queries are collected, and these are used to better train speech recognition. Just follow the prompts to set this up at **https://home.mycroft.ai** from another device; if your audio is working you should hear some actual verbiage at this point. If not you can rerun the setup wizard at any time with `mycroft-setup-wizard` .

Once everything's working, the Mycroft CLI client will start, and you can talk and type at it to your heart's content. Shout the magic wakeword "Hey Mycroft" to prick up its digital ears, then try "Tell me a joke," "What is my IP address?" or "How much wood would a woodchuck chuck if a woodchuck could chuck wood?" He likes it when you say "Thank you" too. Responses are again both verbal and on-screen/terminal. You can quit the CLI at any point with :quit and then you can run anything you'd run on a normal Raspberry Pi Linux install. If you want to get back into the CLI, run

```
$ mycroft-cli-client
```

There's a custom audio setup script called audio_setup.sh, and don't forget to check the excellent Mycroft documentation at **https://mycroft-ai.gitbook.io/docs**. Mycroft can be installed on a regular Linux PC either as a Snap Package, through Docker, or straight from its Github. The wake word engine, known as Precise, uses TensorFlow for cutting-edge accuracy, which requires the host to have AVX extensions: Most machines from the last decade will.

Power and privacy

There's still a couple of 1st-generation Raspberry Pis keeping things ticking over here at *APC*. These older models are great, but lots of projects (such as Mycroft) will require more CPU power, so for a lot of projects you'll see at least a Pi 3 recommended. If you have a Pi 4, you can even run a Jitsi instance that can handle a few callers with no problems. The trouble is, these later models require much more power, so it's important to use a power supply (ideally the official model) that can provide a steady 5.1V supply at up to 2.5A. Cheap USB power supplies can cause all kinds of hard-to-diagnose problems, so if something's behaving oddly, the power is a good thing to check.

Also, we're doing a lot of setting up of web services here, which have the potential to invite the whole world into your machine. So beware of leaving things running with default credentials, and look at firewalling things that only need to run on the local network. You may want to run things in a virtual machine, or on a "disposable" virtual private server to get a feel for them first.

It's your responsibility to maintain these services and keep things up to date too. The journey is far from over once things are up and running. Many companies offerhosted Nextcloud storage, and this may be a better option for small businesses that don't want the burden of administering a server.

Jitsi Meet

Set up, secure, and self-host your way to video-conferencing nirvana, and you'll never have to use Zoom again.

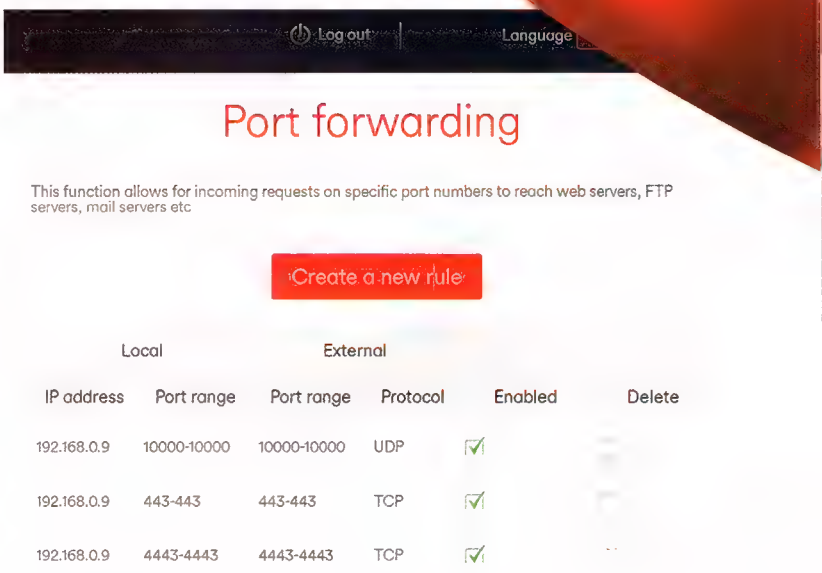
Jitsi Meet is a free, open-source video-conferencing program that you can connect to via a browser or smartphone app. You can use it by visiting **https://meet.jit.si** and choosing a name for your virtual meeting (or accepting one of the amusing ones the website generates). There's no downloads or configuration required by clients, they just need to click a link that you can share by email from within the meeting room, or dial in and connect with a PIN. Simple.

Obviously Jitsi's free service has some limitations, but these will be gone when you self-host your own Jitsi installation. You don't need any particularly special hardware to do this, and thanks to the excellent Debian and Ubuntu packaging, there's not much in the way of configuration at all. You will need a domain name though; a free one from a dynamic DNS service, such as DuckDNS or DynDNS, will work.

As you can imagine (and we'll look at this in a moment if you can't), under the hood Jitsi is a rather complicated affair. Not only does it have to wrangle the vagaries of streaming through NAT gateways (such as home routers), it also needs to keep all this secure with SSL, so if you cheat and use a self-signed certificate, your users will see scary warnings.

If you're happy for you and your users to see these warnings (or brave enough to add an exception to your browser), and your users are all local, then you can get away with a bogus domain name and fudging users'/etc/hosts files to resolve this to your machine. Or even just use IP addresses directly. But it's probably easier in that case to have an in-person conversation rather than involving the machines. If you have a domain, the install process can automatically generate Let's Encrypt certificates, and then no one needs to see any security warnings.

If you don't get your ports right, Jitsi will not play nice.



A Jitsi install is in fact a collection of several components, all working in harmony to bring bright, smiley faces closer in a world that grows ever more distant. Firstly, it relies on a web server (and some pretty wild JavaScript) to provide the web frontend. You can use Nginx or Apache here. Most of the software is written in Java, so keen-eyed dependency spotters will note the OpenJDK runtime making an appearance.

The magic of connecting more than two participants is handled by Jitsi VideoBridge (JVB). This uses the XMPP (like Jabber) and WebRTC (like Google Meet) protocols to swiftly route video to call participants. Deciding which participant is the speaker, and who users see "focused" on their screens, is handled by Jicofo (Jitsi Conference Focus). Note that this is as close to video-processing as Jitsi gets – all the encoding and decoding is handled on the user side. At the heart of it all the Prosody XMPP server keeps all these components and users connected. You'll find more information about these and everything else Jitsi in the handbook at **https://jitsi.github.io/handbook**.

What if it doesn't work?

If you can join a room from multiple locations but don't see any other participants and are stuck with a message telling you you're the only one here, port forwarding is almost certainly the culprit. In some configurations the extra port 4443 will be necessary. Your next stop should be the log files. JVB and Jicofo's are located in /var/log/jitsi and Prosody's is in /var/log/prosody. It's handy to delete these after a configuration change so that you don't get confused by previous logs. Alternatively, use `tail` to view the last few entries. After any configuration change, you'll want to ensure that you restart all the services, which is a matter of:

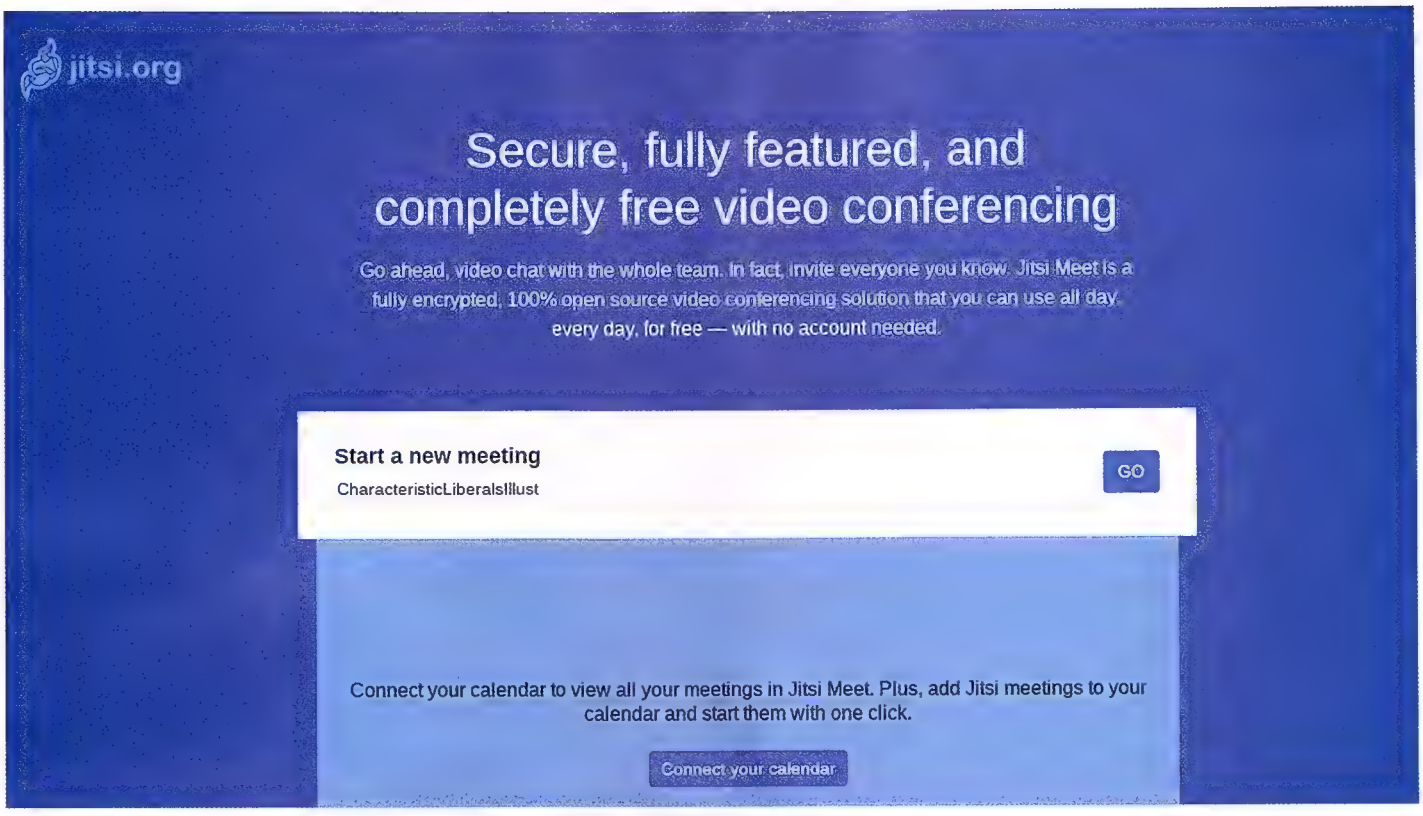
$ sudo systemctl restart jitsi-videobridge2 jicofo prosody

You might want to add `nginx` to that list, particularly if you've changed anything that will affect the frontend, such as the authentication you added earlier. And if it all goes wrong you can purge all Jitsi data and configuration with:

$ sudo apt purge jigasi jitsi-meet jitsi-meet-web-config jitsi-meet-prosody jitsi-meet-turnserver jitsi-meet-web jicofo jitsi-videobridge2

Jitsi? Probably too much coffee

In order for Jitsi to work for users stuck behind NAT, firewalls, or other obstacles in the stack, XMPP messages and web traffic must be able to flow


jitsi.org
Secure, fully featured, and completely free video conferencing
Go ahead, video chat with the whole team. In fact, invite everyone you know. Jitsi Meet is a fully encrypted, 100% open source video conferencing solution that you can use all day, every day, for free — with no account needed.
Start a new meeting
CharacteristicLiberalsIllust
GO
Connect your calendar to view all your meetings in Jitsi Meet. Plus, add Jitsi meetings to your calendar and start them with one click.
Connect your calendar

freely to your server. So you'll need to open UDP port 10000 and TCP ports 80 and 443. TCP port 4443 can be used for fallback communications (if UDP connections are blocked for a user). If you're doing this behind a home router, you'll need to forward these ports.

In an ideal world, one-to-one calls should bypass the JVB, and connect directly to one another (so-called p2p mode), but this may be tricky to negotiate. Prosody can work with a TURN (or STUN) server to facilitate this, but we won't cover this setup here.We will, however, get started with a simple setup after one final warning: The default Jitsi configuration allows anyone to start or join a meeting on your server. If you leave your server running in this way for any length of time, people or bots may discover your machine and can cause trouble. The handbook covers how to set up authentication, which you should do. You should also check the philosophy behind this openness at **https://jitsi.org/blog/security**. You'll be fine using this guide to get things up and running, but make sure you stop the services when they're no longer needed.

And now we can get on with installation. We're more or less following the Self-hosting Guide in the handbook, so do check there if you run into any difficulties. First add the Jitsi repo with:

```
$ https://download.jitsi.org/jitsi-key.gpg.key | sudo sh -c 'gpg --dearmor > /usr/share/keyrings/jitsi-keyring.gpg'
$ echo 'deb [signed-by=/usr/share/keyrings/jitsi-keyring.gpg] https://download.jitsi.org stable/' | sudo tee /etc/apt/sources.list.d/jitsi-stable.list
$ sudo apt update
```

Then let the fireworks begin with:

```
$ sudo apt install jitsi-meet
```

During package configuration, you'll be asked for your Pi's hostname, and whether you want to generate a new, self-signed certificate or use an existing one. Choose the first option if you don't already have a valid one for this domain. Replace it with a Let's Encrypt certificate later. At this point, you should be able to log in to your server using your web browser. Just point it to **https://meet.yourdomain.com** and you'll see the scary certificate warning we warned you about earlier. You can skip this for now (just this once) and you will be greeted by the Jitsi welcome screen, from where you can start a new meeting. Your web browser will ask for permission to use the camera and mic, and you should see a message saying you are the rightful moderator of this room.

Being alone in a room is no fun, so on another device (or get a friend to do this) visit the meeting by appending a slash followed by the room name to the server's URL.

With that working you can now address your server's slightly too "Open for Business" attitude and add some authentication. Edit the Prosody configuration at /etc/prosody/conf.d/meet.

Jitsi is free, easy to use, and its random-name-generation algorithm has been a constant source of amusement throughout these otherwise unamusing times.

yourdomain.com.cfg.lua (replacing the domain name as appropriate). In the section beginning `VirtualHost "meet.yourdomain.com"` change the authentication line, currently set to anonymous, so that it reads:

```
authentication = "internal_hashed"
```

Then add (and adjust the domain in) the following at the end of the file to set up a guest domain:

```
VirtualHost "guest.meet.yourdomain.com"
    authentication = "anonymous"
    c2s_require_encryption = false
```

Don't worry, the extra subdomains configured here are only used internally, so they don't need a bona fide DNS record. Now we'll go from Lua to JavaScript and add the guest domain to the front end. Edit /etc/jitsi/meet/meet.yourdomain.com-config.js and add the following lines to the hosts section:

```
anonymousdomain: 'guest.meet.yourdomain.com',
```

Finally, make focus requests only available to registered users, which is done by editing /etc/jitsi/jicofo/sip-communicator.properties and adding:

```
org.jitsi.jicofo.auth.URL=XMPP:meet.yourdomain.com
```

Now restart the services, and add a user with the `prosodyctl register` command. You can now generate a Let's Encrypt certificate with:

```
$ sudo /usr/share/jitsi-meet/scripts/install-letsencrypt-cert.sh
```

Nextcloud

We've been relying on Nextcloud to keep our files in sync for ages, and we think you should too.

Nextcloud just gets better – the latest edition of the self-hosted storage and sharing platform sees it transformed into a complete collaboration hub.

If you already have a LAMP (Linux, Apache, MySQL, PHP) or equivalent stack set up on a home server or VPS, you can easily add a Nextcloud instance to it, either by extracting an archive to your web server's root directory, or by copying the Web Installer PHP file there and running it directly. Setting up a LAMP stack (or indeed a LEMP stack with Nginx and MariaDB) is easy enough (although it's a bit of a faff having to create databases by hand) in Ubuntu or Debian – there are countless guides a mere search away. This time around we're going to install Nextcloud via Docker. In theory this will mean the instance will be portable, so you could go from running on your VPS to running on a home server, or vice versa, with ease. Data and configuration are stored in volumes outside the Docker container (which you should consider a fairly fungible thing), so migrating the service just involves copying those volumes and connecting them to a new instance of the container.

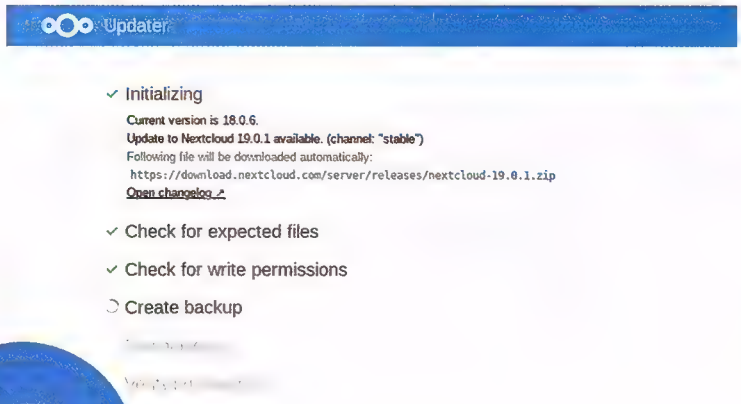
First on the agenda is to install the Docker engine, which requires adding its GPG key to the apt keyring:

```
$ curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key add -
$ sudo apt-key fingerprint 0EBFCD88
```

You should check that the fingerprint of that key matches the one beginning 9DC8 and given in full in the documentation at **https://docs.docker.com/engine/install/ubuntu** (where you can also copy and paste these lengthy commands). Next, add the Docker repos (change `focal` to `bionic` if you're using 18.04), update caches, and install Docker with:

```
$ sudo add-apt-repository "deb [arch=amd64] https://download.docker.com/linux/ubuntu focal stable"
$ sudo apt update
$ sudo apt install docker-ce docker-ce-cli containerd.io
```

If you're already running an older edition of Nextcloud you can upgrade from the comfort of the web interface.



"If you already have a LAMP (Linux, Apache, MySQL, PHP) or equivalent stack set up on a home server or VPS, you can easily add a Nextcloud instance to it"

Check that it's working by running the Hello World image, then fire up the Nextcloud image:

```
$ sudo docker run hello-world
$ sudo docker run -d -p 8080:80 nextcloud
```

The first switch tells Docker to run the container detached (in the background), and the second tells it to expose the container's port 80 (where the web server is running) to port 8080 on your server. So now – once a few hundred megs are downloaded and the container springs in to life – if you browse to **http://yourserver: 8080** (with your address or hostname) you should find the Nextcloud welcome screen. You'll see a warning about the container using SQLite; this lightweight database will be fine for a few users, but more popular setups will need a proper MySQL or MariaDB instance. Go back to the terminal, find your container's name (from the last column of the first command), and stop it with:

```
$ sudo docker ps -a
$ sudo docker stop yourcontainername
```

At this point you could connect Nextcloud to a MariaDB container, and have both store data in named volumes, which will provide portability. The volumes will be available in the /var/lib/docker/volumes/ directory. You can also add boring names to containers.

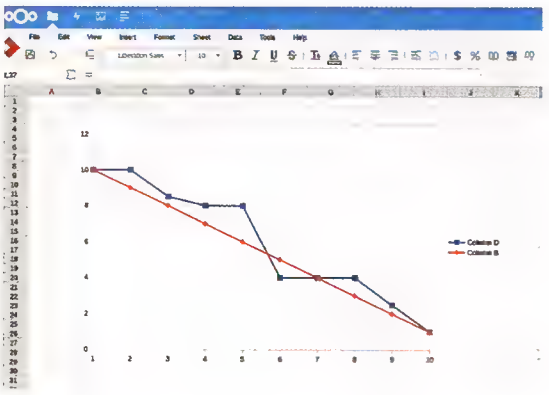
```
$ sudo docker run -d -p 8080:80 –name nextcloud -v nextcloud:/var/www/html nextcloud
$ sudo docker run -d -v db:/var/lib/mysql –name mydb -e MYSQL_ROOT_PASSWORD=secret1 mariadb
```

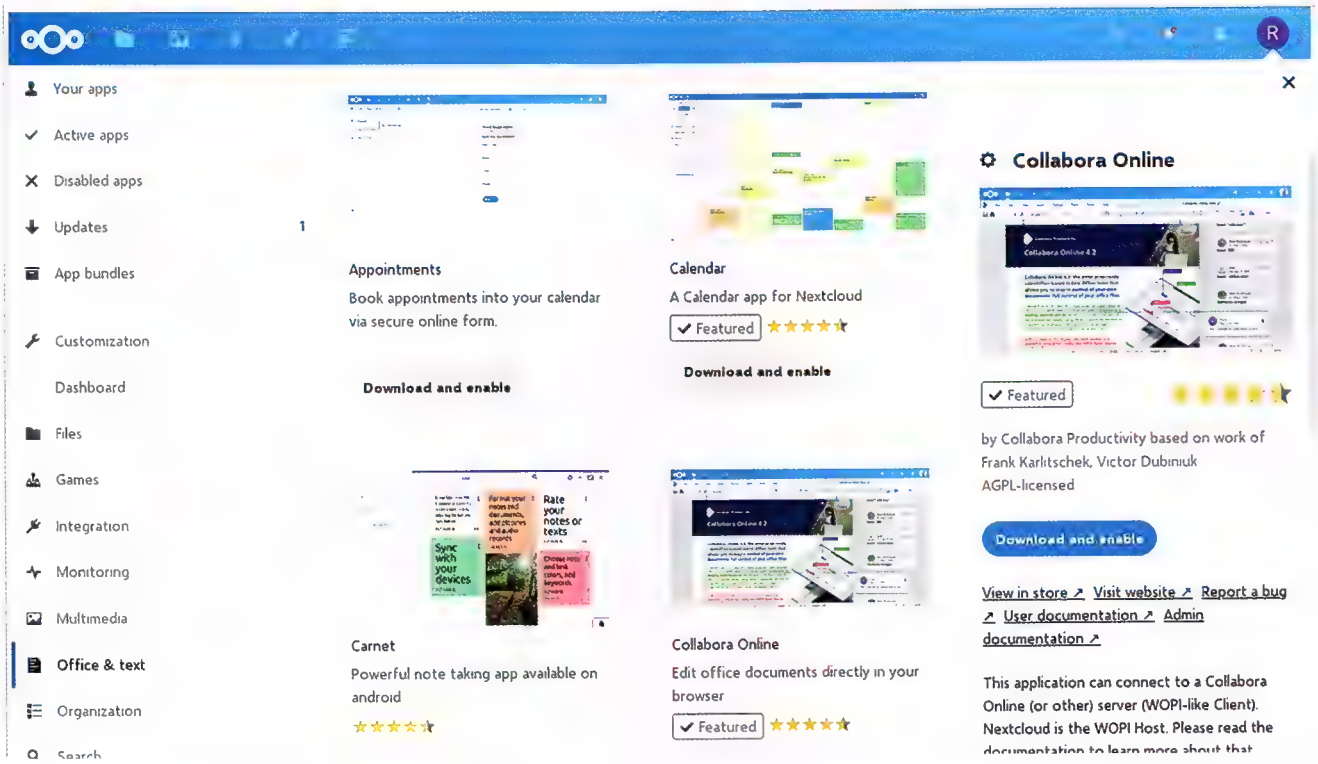
Getting these two containers to talk to each other is tricky, so refer to the Docker Compose section in the documentation, but we'll return to this idea soon. Containers still continue to exist after they've been stopped. Multiple instantiations of the same one aren't a space issue, since the layers of the union filesystem are shared between them. But it's polite to tidy up, so check your containers occasionally with `docker ps` and clear unwanted ones, such as the database above, with:

```
$ sudo docker rm mydb
```

If you want to get rid of everything (danger, beware), you can do so with:

Spreadsheets and charts within web apps and without Google. We're pretty sure Collabora is onto a good thing.





Jazz up your Nextcloud install with a dizzying array of add-ons. We're big fans of the News app.

```
$ sudo docker rm $(sudo docker ps -aq)
```

You can at this point go back to the web installer and enter some administrative credentials, doggedly proceeding with the SQLite database, and reusing the first volume. But we're going to borrow from the community and use the example Docker Compose setup, skimming over a few details that you should check in the documentation. Running Docker this way uses four containers, one of which is a reverse proxy running Nginx, which can provide SSL encryption (essential if you make this installation available to the internet at large). Also in this setup is a Let's Encrypt host to automatically update certificates. If you've got a domain name setup, the whole thing will be seamless.

Grab the Compose recipe and environment from the Tutorials download, or fetch it from the nextcloud/docker repo on Github. Edit the docker-compose file, setting in particular the MySQL password, the virtual host (your domain name), and Let's Encrypt variables. Follow the official documentation to install Docker Compose at **https://docs.docker.com/compose/install**, as this process may change. If something doesn't work, peer into the logs of each container, for example:

```
$ sudo docker logs compose_proxy_1
```

One way or another, you'll find your way back to the Nextcloud setup screen, and then all further configuration will be free of terminal commands. You just need to choose an admin password, use `db` for the database name (it uses Docker's internal networking so doesn't need a domain name), and wait a few moments for everything to be initialised. Your first step should be to create a new user, which you can do from the "Users" section in the dropdown menu in the top right. It's better to keep the admin account for, well, admin. While you're here, you can use your administrative privileges to see how apps are added to Nextcloud. Select "Apps" from the user menu in the top right, and you'll find a categorized list of them.

It's good practice to keep your containers updated with the command:

```
$ docker-compose pull
```

from the directory with the docker-compose.yml file.

Collabora Online

Collabora has just released the latest version of its enterprise edition of LibreOffice: Collabora Office 6.4 (see **www.collaboraoffice.com**). Alongside that offering is another enterprise release, Collabora Online, which provides an online version of the office suite that can be plugged into a file sync and share host via the Web Application Open Platform Interface (WOPI).

A free version of Collabora Online – the Development Edition, aimed at home users – is available, and it can be connected to your Nextcloud instance to provide functionality not entirely dissimilar to Google Docs.

The easiest way to set it up is to use the Docker image and follow the instructions at **https://nextcloud.com/collaboraonline**. The CODE docker image listens on localhost:9980, so for this to be accessible to the outside world the instructions should use an Apache reverse proxy. It's recommended to have this proxy run on a different domain (the same machine is fine) to your Nextcloud host, which is a little complicated because for this to work smoothly you need to have valid SSL certificates for both.

It's possible to use the same domain (at a cost to security), or self-signed certificates, but you may have to be creative in your approach here. Once you've done the hard work, install the Collabora Online app using your Nextcloud admin account, and then configure it with the domain where the proxy is listening.

We haven't heard the term "groupware" since Novell Netware, but we're glad Collabora is bringing back the term with such style.

Portainer & Docker

Contain your sprawling smart home office with Portainer, then ruminate on a fully featured email server with Mailcow.

When you're running a home server or VPS, Docker is pretty great because you can add services without messing (too much) with the underlying system configuration. As we've seen with Nextcloud, though, even with just four Docker containers things become unwieldy. Portainer is a Docker management system that aims to restore order.

It comes in two parts – server and agent – which both ship as Docker containers. you'll only need the server image for this initial foray. The agent is used to marshall Docker Swarms, which are another way of connecting containers together. Let's start by creating a volume for data, and then firing up the image.

```
$ docker volume create portainer_data
$ docker run -d -p 9000:9000 --name=portainer --restart=always -v /var/run/docker.sock:/var/run/docker.sock -v portainer_data:/data portainer/portainer
```

Note that images can be added according to their listing on Docker Hub, so you can find out more about the Portainer image at **https://hub.docker.com/r/portainer/portainer**. You should find Portainer's admin panel now waiting for you on port 9000, so point your browser there, choose a password, select "Manage the local Docker environment" and enjoy the friendly interface. If you installed Nextcloud through Docker earlier, you should see all those containers listed in "Local Endpoint" on the Home screen. If you click "Containers" on the menu on the left, you'll see these (and our latest Portainer container) in more detail. The quick-actions column allows you to see each container's logs, info, stats, and log in to each one directly from the browser. This is a great way to do some troubleshooting, but recall that containers in general are quite minimal, so you won't find any fancy utilities.

Besides running locally, Portainer can be used to manage remote systems running its agent.

"As we've seen with Nextcloud, though, even with just four Docker containers things become unwieldy. Portainer is a Docker management system that aims to restore order."

Adding a new container is easy. For example, if you want to add Collabora's CODE, and connect it with a Nextcloud install, hit the "Add Container" button and enter a meaningful name. In the "Image" field enter `collabora/code` , and in the "Manual network port publishing" section enter `127.0.0.1:9980` in the host field and `9980` in the container field. In the "Advanced" container settings below, go to the "Env" section and set the following environment variables:

```
domain: share\\yourdomain\\.com
username: admin
password: yourpassword
```

Finally, in the "Restart policy" column select "Always," so the container restarts upon configuration change. Hit "Deploy," and the container will spring into life. For guidance connecting it to your Nextcloud instance, check the documentation at **https://nextcloud.com/collaboraonline**. All going well, you should be able to specify it from Nextcloud, specifically from the "Collabora Online" section in "Settings." You may need to tweak the reverse-proxy container to direct traffic to the new container, if you used the Docker Compose example on the previous page.

In that case you'll find that example in the "Stacks" section with a warning about it being created outside Portainer. In Portainer parlance, groups of containers are called Stacks, and it can only do limited things with externally created Stacks. However, it's easy to create a new Stack; just paste, upload, or point Portainer to the URL of a docker-compose.yml file.

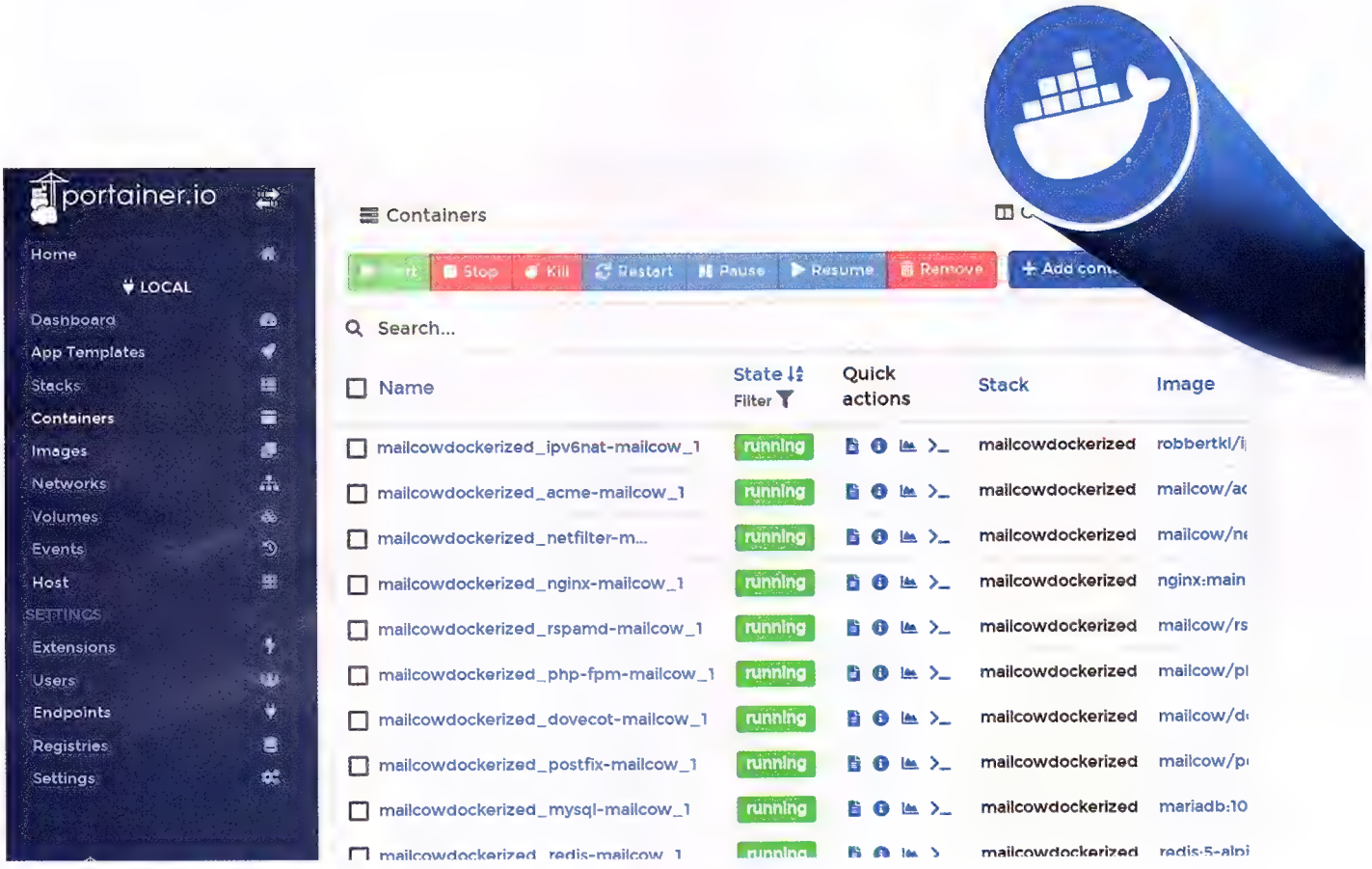
Nextcloud's own groupware – its Calendar, Talk and Mail applications – can be used for collaboration among users. The Mail app is just a client, so set it up with a provider as you would in a desktop email client. It's often been said that setting up an email server properly is hard. This is true, but you can set up a rough-and-ready container

Jitsi Pi in the sky/cloud

If you're feeling adventurous, it is possible to install Jitsi Meet on a Raspberry Pi 4 with 4GB (the 8GB version will perform better though). This isn't officially supported and setup is a little complicated. Also our Pi 4s are all locked up in our offices until such time as it is deemed COVID-proof.

We were feeling extravagant so we took advantage of Mythic Beasts' commitment-free, per-second billing and rented ourselves a remote Pi 4. Mythic Beasts' offerings use PXE booting and mount the root filesystem via NFS from their own storage arrays. This means you're not at the mercy of unreliable SD cards, and also allows you to rent up to 250GB of storage. We were more frugal, however, and went with the minimum 10GB.

If you're setting up Jitsi on your own Pi locally you might have to do a little detective work (or plug in a monitor) to find your Pi's IP address on your LAN. And if you use Mythic Beasts' offering be aware that its Pi servers are connected by IPv6 only. A gateway is available so that IPv4-only users can still connect to it, but you'll need a real DNS record (DuckDNS doesn't count here) to use it for anything other than as a standard web host. We were a bit embarrassed that it took us a while to figure this one out.



running Postfix, Dovecot, and Roundcube and have a working (but not necessarily well-configured) email setup in just a few keystrokes thanks to the Mailcowdockerized image.

Setting this up might offend the sensitivities of those adverse to running things as root, but the image uses extended attributes and requires it. So let's be a superuser and check that our umask is set correctly (it should print 0022).

```
$ sudo -i
# umask
```

Now we'll clone the repository into /opt:

```
# cd /opt
# git clone https://github.com/mailcow/mailcow-dockerized
# cd mailcow-dockerized
# ./generate_config.sh
```

You'll be asked for your domain name; this is the host that it's running on, not the domain of any email addresses you want to set up. If your machine has limited memory, the script will suggest that you disable Solr (the heavy-duty Java search platform), which you should. The script generates mailcow.conf, which you may wish to tweak. We'll just plough right ahead. First, in case they get in the way, stop Nextcloud and any other containers now. In Portainer, do this by choosing "Containers" from the menu on the left, selecting all of them except Portainer (because that would be silly), and pushing the stop button. There's a "Kill" button next to it in case they don't shut down gracefully, and you can also remove them entirely if you don't like them.

Now return to the terminal (still using the root account) and let's fetch and unleash the Mailcow:

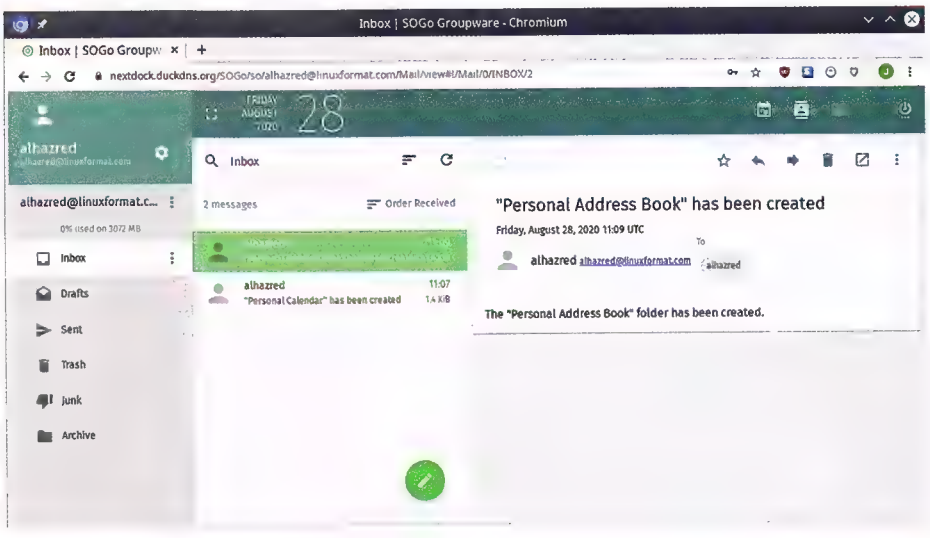
```
# docker-compose pull
# docker-compose up -d
```

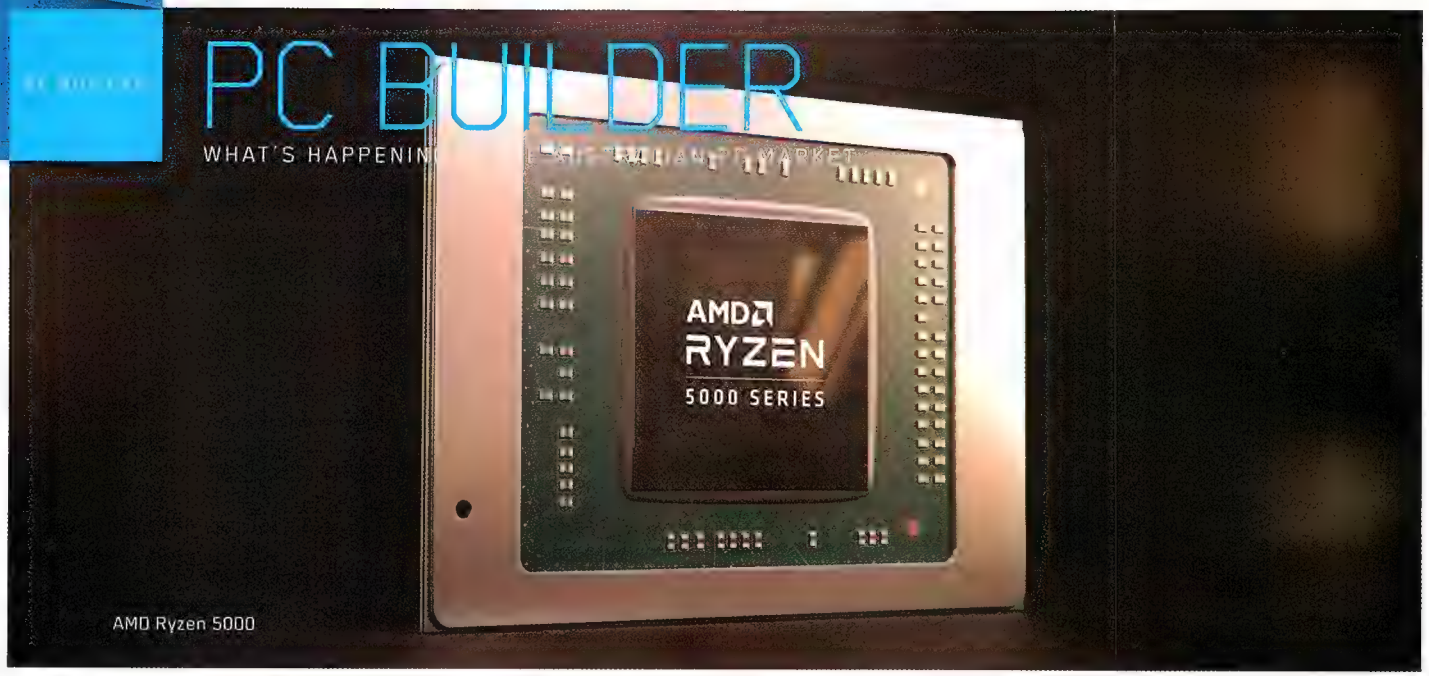
At this point, you technically have a working mail server. You should be able to log in from the web interface, using the credentials admin:moohoo . But there's still a lot of configuration to do, not least changing that password: Click "Edit" next to the admin user. If you want to receive mail you'll need to properly set up MX records for your domain(s) with your DNS provider, otherwise mail won't be routed correctly.

Then you can configure them from Mailcow's "Domains" section, and can configure the addresses in the "Mailboxes" section. In a world of spam, do your bit by enabling DKIM (Domain Keys Identified Mail), which signs messages originating from your server. DKIM-enabled servers will verify this key when they receive mail from your domain, preventing malfeasance. ■

Mailcowdockerized involves about 20 containers, but you can disable a few of them. Great again.

Once you've set up your mailboxes, you and your users can log in to the SOGo webmail client by adding /SOGo to Mailcow's domain name.





AMD Ryzen 5000

System news

With CES wrapped up Mark Williams is excited for the year of tech ahead.

CES kicks off every year with a plethora of new technology and product announcements that gets everyone excited for all the new tech coming over the coming year. This year was no exception, with everything revealed from high tech face masks (Razer's Project Hazel), expandable phone screens (LG Rollable) and drones (Sony Airpeak) through to cute AI powered furry robot pets (Moflin), CES was still quite the success despite being an all-digital COVID-19 induced affair this year.

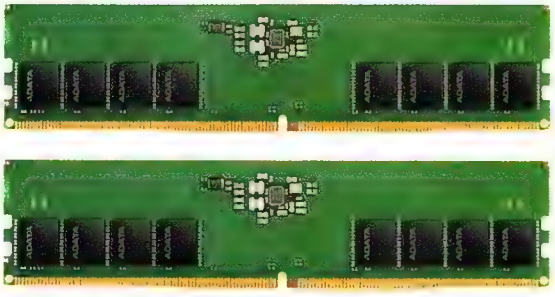
MARK WILLIAMS
Mark is an IT professional with a strong interest in voiding warranties.

Mobile Ryzen 5000

AMD's CEO Dr Lisa Su announced the launch on Zen3-based Ryzen 5000 processors for the mobile segment, ranging from an 8-core 4.8GHz boost clocked Ryzen 9 5980HX at the top end, right down to the quad core 3.8GHz boost clocked Ryzen 3 5300U at the low end.

Incredibly, eight of the thirteen processors announced were 8-core! AMD will have a firm grasp in the ultrathin category. Showing off some internal benchmark results, AMD showed its 5800U beating Intel's i7-1185G7 in productivity by anywhere from seven percent all the way up to 44 percent – insane!

A word of warning however. If you find yourself looking for a Ryzen 5000 powered laptop this year beware of Ryzen 7 5700U, Ryzen 5 5500U and Ryzen 3 5300U parts, as strangely these are still based on the outgoing Zen2 architecture.


Below: Adata DDR5.

Nvidia RTX 3000-powered laptop.

RTX 3000 laptop GPUs

Nvidia revealed its hotly anticipated line-up of "RTX 3000 Laptop" series GPUs. In a shift away from the 2000 series philosophy of giving the laptop parts the same CUDA core counts as the desktop ones and down clocking them, with the 3000 series Nvidia has had to compromise and reduce the size of the GPUs to reign in the 3000 series' well-known penchant for being power hungry.

It seems this launch has also ushered in a wave of 1440P laptop displays with higher refresh rates, ditching the marketing mantra of higher resolution is better and listening to what consumers have been asking for in higher refresh rate 1440P displays. One trend I'm extremely happy to see unfold this year.

DDR5

Adata unveiled a render of what its first DDR5 memory module will look like as well as some speed specifications.

The memory module looks like any other green PCB DDR4 based module, although the keyed notch in the data pins is awfully close to dead centre, meaning just looking at it one cannot easily tell which way is which. I foresee DDR5 installations being frustrating with multiple insertion attempts having to be made to figure out the module's orientation for the slot.

With speeds of up to 8400MT/s, DDR5 is going to be a big jump in bandwidth over DDR4.

Expect to see DDR5 make its debut to the consumer space in the second half of this year with new platforms from AMD and Intel to support it. ■

Market snapshot

An overview of typical systems in today's market.

$4,149 | tinyurl.com/APC491PLE

PLE Raven

Aiming at top performance figures without breaking the bank, this system strikes a good balance. The CPU by itself isn't the best deal around for gamers, but it's really as high as you need to look in AMD's product stack. Dropped into a lovely motherboard and cooled with a triple fan AIO solution, you'll struggle to find a situation where the CPU is the bottleneck. The RX 6900 XT GPU trades blows with the RTX 3090 and 3080 and costs far less than the former. Perfect for non-ray traced gaming at high resolutions and frame rates. Memory is a touch slower than ideal, but ok. The 500GB 980 Pro SSD is an odd choice. For basically the same price, a 1TB 970 EVO drive would've been a better option here. A great system for serious gamers.

CPU: AMD Ryzen 7 5800X **Cooler:** EK AIO 360 D-RGB **Motherboard:** Asus ROG Strix X570-F Gaming **Graphics:** XFX RX 6900 XT 16GB **Memory:** 32GB Corsair Vengeance RGB Pro 3200MHz **Storage:** Samsung 980 Pro 500GB NVME M.2 SSD, WD Blue 2TB HDD **Power Supply:** Not Specified **Case:** Lian-Li O11 Dynamic

$7,299 | tinyurl.com/APC491JWC

JW Computers GMR Dominator 3090

JW will dominate your wallet with this PC. A killer system that appears to have tried to cram the best of every component category in there. Almost. The RTX 3090 is undeniably the best GPU currently, and consumes over 40% of the sticker price. Mated with AMD's 5950X for ultimate gaming and productivity performance, there is no better combination. 64GB would've also been nice given the tasks a 16-core processor would be expected to deal with. The sole 1TB NVMe SSD is great though for serious gamers and productivity nuts; 2TB would've been nicer. The PSU is a little overkill but if overclocking is on the cards it'll definitely be needed.

CPU: AMD Ryzen 9 5950X **Cooler:** Corsair H100i RGB Platinum AIO **Motherboard:** Gigabyte X570 Aorus Master **Graphics:** Gigabyte Aorus Master RTX3090 Gaming 24GB **Memory:** Corsair Vengeance Pro 32GB DDR4 3600MHz **Storage:** 1TB M.2 NVME Samsung 970 Evo Plus **Power Supply:** Coolermaster V1300 **Case:** Corsair iCUE 4000X ARGB

$1,399 | tinyurl.com/APC491PCC

PC Case Gear Aero 580

Coming in $50 cheaper than the Scorptec system this month, this system has a solid base in the B450 platform it's built upon, which will allow for easy processor upgrades should the urge strike. And strike it will, as this rig comes with one of AMD's weakest CPU offerings in the Ryzen 3 3100. Quad core is ageing poorly for games now, and this will be no exception. Paired with an RX 580, which amazingly is coming on four years old now, you can see the CPU will be the least of your problems on the gaming front. Offering GTX 1650 Super levels of performance, 720P and 1080P gaming is all this system will be capable of.

The RAM is half decent and the SSD will prove small quickly.

CPU: AMD Ryzen 3 3100 **Cooler:** OEM **Motherboard:** MSI B450M Mortar Max **Graphics:** MSI Radeon RX 580 Armor OC 8GB **Memory:** Team T-Force Delta RGB 16GB 3200MHz CL16 DDR4 **Storage:** Kingston A400 SATA SSD 240GB, Seagate Barracuda 2TB HDD **Power Supply:** Aerocool Aero Bronze 80 Plus 550W **Case:** Aerocool Aero One Frost mATX RGB

$1,449 | tinyurl.com/APC491SCO

Scorptec Precision GTX 1650 Super

In a similar price bracket to the Aero 580 system, this gaming rig is quite cheap, though has some positive points over the Aero. The CPU, while similar in multithreaded performance to the Ryzen 3100, pulls out 20 percent and 12 percent performance average leads in games at 720P and 1080P respectively. So out of the box it offers the best headroom but has a platform on which upgrading doesn't make a whole lot of sense due to restrictions and incompatibility with newest generation parts. The SSD at least is a good size and is NVMe to keep things snappy. A worthy system for those on a budget, as long as you're aware of the upgrade limitations.

CPU: Intel Core i5 9400 **Cooler:** OEM **Motherboard:** Asus TUF B365M-PLUS **Graphics:** Asus Phoenix GeForce GTX 1650 Super OC 4GB **Memory:** Corsair Vengeance LPX 16GB 2666MHz DDR4 **Storage:** Western Digital WD Blue SN550 500GB M.2 SSD, Seagate BarraCuda 2TB HDD **Power Supply:** SilverStone Essential 550W **Case:** SilverStone Precision PS15 RGB Black mATX

BLUEPRINTS

VALUE- AND PERFORMANCE-DRIVEN HYPOTHETICAL BUILDS

PC BUILDER

Budget

Competent.

We are still in the throes of supply shortages right now. And you can see that across both our budget builds. We've managed to claw back some costs, but sadly GPU prices on the low-end are still at unmanageable levels, and stock is precarious. To that end we've swapped to the MSI Radeon RX 5500 XT Gaming X for our AMD system, and the GeForce GTX 1650 Super OC on Intel. Both are roughly the same price, and perform similarly – the 1650 Super edges out the 5500 XT for performance and is slightly cheaper too, although both are floating above their RRPs annoyingly.

We've also had to swap out our Intel processor from the Core i5-10500 to the Core i3-10100. This saves us a ton of cash, bringing that processor price down to just $130. It's also cheaper than the AMD Ryzen 3 3100 in our Red build, and it performs ever so slightly better, and of course comes with Hyper-Threading, so you still got those four cores and eight threads.

Memory is a bit of a sticking point for this build, but we've kept the 16GB in play. Theoretically you could possibly get away with 8GB of DDR4 if you really need to shave off some cost, but that extra memory headroom will do a ton of good. One place you could save money on this build would be by dropping the secondary storage, saving you $110 on each build. Alternatively, with the Intel setup you could take the GPU out of the equation entirely and bring the price down to just $950. Sadly that's not possible with the AMD system as the Ryzen 3 3100 lacks integrated graphics.

It's a tricky time to be a PC enthusiast, but unfortunately there's not much we can do about it. It's a snowball effect: More people are at home on their PCs, and as always with new launches production is a bit slow, and those two factors, combined with some economic ones, are having a significant impact across the entire sector, from consoles to phones to PC parts.

AMD INGREDIENTS

PART		PRICE
CASE	CORSAIR 4000D AIRFLOW	$130
PSU	450W EVGA 450 BR 80+ BRONZE **NEW**	$60
M/BOARD	GIGABYTE B450M DS3H V2 **NEW**	$120
CPU	AMD RYZEN 3 3100	$175
GPU	MSI RADEON RX 5500 XT GAMING X NEW	$370
RAM	16GB (2 X 8GB) ADATA XPG D60 @ 3000 MHZ **NEW**	$130
SSD	250GB SAMSUNG 980 PRO M.2 PCIE 4.0	$120
HDD	1TB WESTERN DIGITAL RE4 3.5-INCH HDD **NEW**	$110
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$1,275**

INTEL INGREDIENTS

PART		PRICE
CASE	CORSAIR 4000D AIRFLOW	$130
PSU	450W GIGABYTE GP-450B 80+ BRONZE	$70
M/BOARD	MSI B460M-A PRO MICRO-ATX **NEW**	$130
CPU	INTEL CORE I3-10100 **NEW**	$130
GPU	GIGABYTE GEFORCE GTX 1650 SUPER OC **NEW**	$260
RAM	16GB (2 X 8GB) ADATA XPG D60 @ 3000 MHZ	$130
SSD	500GB SAMSUNG 970 EVO M.2 PCIE 3.0 SSD	$120
HDD	1TB WESTERN DIGITAL RE4 3.5-INCH HDD **NEW**	$110
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$1,140**

PC BUILDER

Mid-range

Decent.

As for our mid-range builds, things are starting to look a bit better. On the whole we haven't been forced to make many changes, and we've actually managed to drop the price of both systems.

The big changes in the AMD build are the new power supply – a snazzy RGB 650W Corsair affair – new cooler, the HS60 120mm AIO – again from Corsair, and some serious shake-ups to storage. Amazingly GPU prices are actually holding steady this time around, so there's less worry there. However, AMD's latest Ryzen 5000 series are still MIA as far as the tech world is concerned. If you can get one, jump on it. The X570-Plus will support it, and the improved single-core performance is not to be sniffed at.

For our Intel system, the changes have been less dramatic. We're still holding onto that Core i7-10700 processor, but we've also swapped out a few of the other components, including the GPU and the motherboard. The Aorus Elite AC is a fantastic little number for any LGA1200 chip, and has some impressive connectivity for the price. We've also managed to snag this excellent MSI GeForce GTX 1660 Super 6GB Ventus XS OC (who comes up with these names?), which is much cheaper than our AMD equivalent, and performs only slightly worse, which in our eyes is a win. Either card is a good choice for 1440p gaming, and you should be able to achieve a comfortable 45-60fps in most titles on ultra.

As for memory, we're still sticking with 16GB across the board here, although it's that grey area where you might be better off opting for a 32GB kit instead. Pair all this together with that extra RAM and you'll find yourself with a fantastic video-editing and photo-editing system, ideal for any hobbyist or enthusiast keen on getting their face out into the digital world.

AMD INGREDIENTS

PART		PRICE
CASE	LIAN LI PC011-DYNAMIC	$210
PSU	650W CORSAIR CX650F RGB 80+ BRONZE **NEW**	$150
M/BOARD	ASUS TUF GAMING X570-PLUS	$349
CPU	AMD RYZEN 5 3600	$300
COOLER	CORSAIR H60 120MM AIO **NEW**	$120
GPU	MSI RADEON RX 5700 GAMING X 8GB	$710
RAM	16GB (2 X 8GB) G.SKILLS RIPJAWS V @ 3600 **NEW**	$130
SSD	500GB SABRENT ROCKET 4.0 M.2 PCIE 4.0 **NEW**	$120
HDD	1TB WESTERN DIGITAL RE4 3.5-INCH HDD **NEW**	$110
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$2,259**

INTEL INGREDIENTS

PART		PRICE
CASE	LIAN LI PC011-DYNAMIC	$210
PSU	650W COOLER MASTER MASTERWATT 650	$110
M/BOARD	GIGABYTE Z490 AORUS ELITE AC **NEW**	$349
CPU	INTEL CORE I7-10700	$450
COOLER	COOLER MASTER MASTERLIQUID ML240L AIO	$100
GPU	MSI GEFORCE GTX 1660 SUPER 6GB VENTUS XS OC **NEW**	$460
RAM	16GB (2 X 8GB) CRUCIAL BALLISTIX @ 3200 **NEW**	$130
SSD	500GB WD BLACK SN750 M.2 PCIE 3.0	$140
HDD	1TB WESTERN DIGITAL RE4 3.5-INCH HDD **NEW**	$110
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$2,119**

PC BUILDER

Turbo

Stupendous.

It's happening people, you can finally pre-order an AMD Ryzen 9 5900X at a respectable price! OK, so it might not be in stock as we write this (hopefully it will be as you're reading it), but the impeccable 5900X is now available for pre-order across a number of major e-tailers, and we've added it to the Turbo AMD build, swapping out the somewhat aged 3950X. It might not have the 16 cores that its older brother has, but with a new cache design, far superior single-core performance, and access to some smart cache graphics systems, it's a terrific chip that can do it all, and still keep cool. It's also saved us nearly $240, so losing those four extra cores doesn't seem like that big of a deal here.

We've also swapped out the motherboard, power supply (for the more modern RM version as opposed to the RMx), and the memory to make this a far cleaner system. And last but not least, we've found a well priced Nvidia GeForce RTX 3080 10GB that you can pre-order for its retail price as well. Incredible! In fact both systems are sporting our Asus GPU of choice this time around.

Over to our Intel system, and the changes have been far more subdued (mostly due to the fact that Intel isn't suffering from quite the same level of stock shortages as AMD). We're still keeping hold of the Core i9-10900K, but have switched out the motherboard for an Asus PRIME Z490-A. It's a slicker, professional-oriented budget Z490 board, and it's an awesome pick.

As for storage, we've dropped down from the WD Red Pro HDD to just the standard Red, for what we're doing here, this should be fine. And lastly our Intel system has moved over to the Corsair MP400 1TB M.2 PCIe 3.0 SSD – welcome to the world of what QLC should've been to begin with.

AMD INGREDIENTS

PART		PRICE
CASE	PHANTEKS ENTHOO PRO 2 TEMPERED GLASS	$220
PSU	750W CORSAIR RM750 80+ GOLD **NEW**	$200
M/BOARD	MSI MAG X570 TOMAHAWK WIFI **NEW**	$340
CPU	AMD RYZEN 9 5900X **NEW**	$859
COOLER	CORSAIR ICUE H150I ELITE CAPELLIX 360MM AIO	$300
GPU	ASUS GEFORCE RTX 3080 TUF GAMING OC **NEW**	$1,489
RAM	32GB (2 X 16GB) G.SKILL TRIDENT Z NEO @ 3600 **NEW**	$270
SSD	1TB GIGABYTE AORUS GEN4 M.2 PCIE 4.0	$280
HDD	6TB WESTERN DIGITAL RED HDD **NEW**	$360
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$4,378**

INTEL INGREDIENTS

PART		PRICE
CASE	PHANTEKS ENTHOO PRO 2 TEMPERED GLASS	$220
PSU	750W BE QUIET! STRAIGHT POWER 11 80+ GOLD **NEW**	$200
M/BOARD	ASUS PRIME Z490-A **NEW**	$350
CPU	INTEL CORE I9-10900K	$700
COOLER	NZXT KRAKEN X73 360MM	$300
GPU	ASUS GEFORCE RTX 3080 TUF GAMING OC **NEW**	$1,489
RAM	32GB (2 X 16GB) CORSAIR VENGEANCE RGB PRO @ 3600	$250
SSD	1TB CORSAIR MP400 M.2 PCIE 3.0 SSD **NEW**	$240
HDD	6TB WESTERN DIGITAL RED HDD **NEW**	$360
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$4,169**

Super storage station

Zak Storey gets to work building our own full-tower storage house

LENGTH OF TIME: 1-2 hours
LEVEL OF DIFFICULTY: easy

"As you can probably tell the concept behind this build is simple: To create a fantastically concrete media server, where we can store our APC content."

Oh boy this is a big one. It's one of those builds that you sort of plan out at first, thinking, "Ah this will be easy, and affordable, and realistic," and then you get to the end of requesting in all those parts and what you're left with is a massive price tag. It happens more often than you'd think. Yes, if you take a quick glance over to that ingredients list to the right, you'll see that our secondary storage of choice takes up a whopping 67 percent of our total budget. That's nuts.

However, it does bring to light one perhaps obvious fatal flaw when it comes to a system build quite like this. As you can probably tell the concept behind this build is simple: To create a fantastically concrete media server, where we can store our *APC* content. But there's one problem for the average Joe – that it is an insane amount of money to spend on storage.

The reality is, if you swap those out for just standard Western Digital Red Pro 4TB HDDs, you'd be looking at a price of around $750. That's near enough a third of what you'd actually spend on those SSDs – crazy huh? SSDs have come a long way for sure, and their performance is undeniably superior in almost every metric, but they're just nowhere near the same cost-effectiveness when it comes to mass storage and server setups like this.

Perfect storage?

Realistically, unless you need super-fast storage, dropping $2,500 on SSDs might not be the smartest idea. In fact, there's a few areas with this build where you can swap parts around, and interchange stuff to really tailor it to your specific requirements. For instance, if you want to make this a media-streaming build for your whole family, you might be better off getting a 24-core Threadripper, and a dedicated GPU with some solid 7,200 RPM HDDs. If you are looking to create a remote rendering station, then dropping storage capacity by half and investing in a lot more memory would go a long way. Want an ultimate gaming rig with a boat load of storage in the back? Then a Ryzen 9 5900X, AMD Radeon RX 6800 XT, and 4TB of SSDs would be a perfect solution.

There's a ton of ways you can customise this very specifically to your needs. The reason we've gone the way we have (aside from the aforementioned need for somewhere to back up our video content) is first and foremost because we really want to see just how good Phanteks's Enthoo Pro 2 is when it comes to building a NAS-like media server.

And the thing is a beast. Complete with ample airflow, support for two systems, oodles of GPUs, and even twin-socket motherboards if you so desire, this thing is a monster. In fact it's so big you could theoretically fit 12x 3.5-inch drives and 3x 2.5-inch drives all at the same time. As standard there's support for 4x 3.5-inch drives and 11x 2.5-inch SSDs with brackets included. As an aside, to get that extra storage space, you'd have to buy an additional four pairs of brackets from Amazon, at $22 a go, bumping up the total case price to $308 (search PH-HDDKT_03). Not too shabby. But enough of that, let's get to it.

INGREDIENTS

PART		STREET PRICE
CASE	PHANTEKS ENTHOO PRO 2	$220
MOTHER-BOARD	MSI MPG Z490 GAMING CARBON WIFI	$450
CPU	INTEL CORE I5-10500	$330
MEMORY	8GB (2X4GB) CORSAIR VENGEANCE LPX @ 3000 CL16	$65
PSU	500W EVGA BR 80+ BRONZE	$120
PRIMARY STORAGE	120GB WESTERN DIGITAL GREEN M.2-2280 SSD	$60
SECONDARY STORAGE	12TB (3X4TB) WESTERN DIGITAL RED SA500 2.5-INCH SSDS	$2,520
CPU COOLER	NOCTUA NH-U12S	$120
OS	WINDOWS 10 HOME 64-BIT OEM	$60
TOTAL		$3,945

prices correct at time of printing.

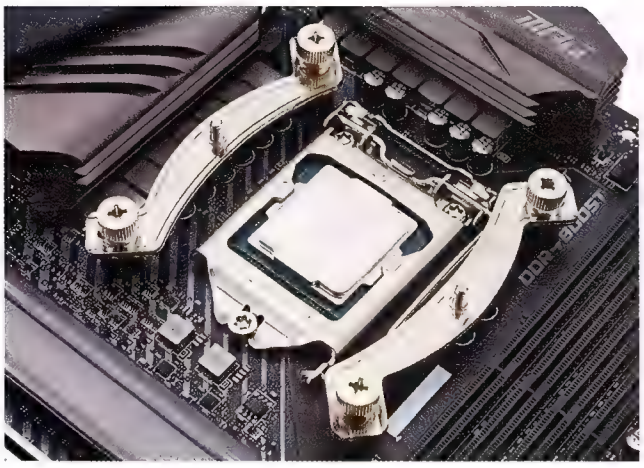
"The thing is a beast. Complete with ample airflow, support for two systems, oodles of GPUs, and even twin-socket motherboards if you so desire, this thing is a monster."

01 GUTTING MONSTERS

There's no doubt about it: The Enthoo Pro 2 is big, seriously big. It comes in at 9.5 x 22.8 x 22.0in (WxHxD) and weighs 28.7lbs empty. That's huge. It's got space internally for multiple systems, dual-socket motherboards, and up to 1,820mm of liquid-cooling radiator surface area if you so desire. It's just so versatile, it's extreme. To get this far, pop the front panel off by pulling from the bottom, remove the magnetic dust filter on the top, and carefully place the tempered-glass side panel and rear panel into the cardboard box it came in. Sticking them between the packing material ensures that you don't lose them, and that nothing scratches them throughout the build process.

02 MOTHERBOARD BRIGANDS

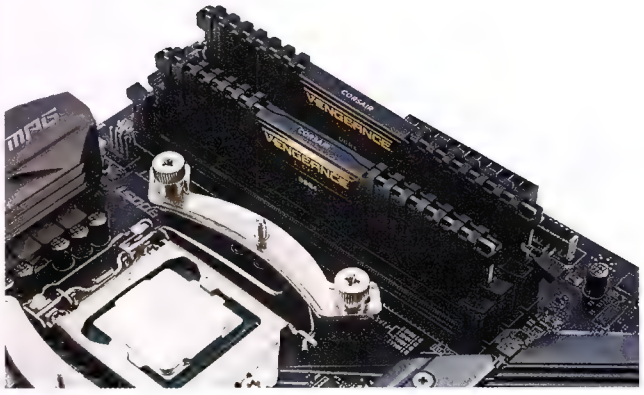
Our motherboard is MSI's Z490 Gaming Carbon WiFi. It's not a mind-blowingly expensive board, but packs in enough features to keep us happy, suitable for our Core i5-10500, up to 128GB of DDR4, and six SATA connections straight out of the gate. It's the I/O that interests us the most, as it comes with a 2.5G Ethernet connection, multiple USB 3.2 Type C ports, and WiFi AX 6 as well, meaning as far as getting data to this machine goes, we've got options. It's even got a PS/2 port if we want to get old school. There is one slight problem: If we want to add drives to our array at a later date in the form of 3.5-inch HDDs we're going to have to install an add-in RAID card as well. Six SATA ports just isn't going to cut it.



03 CPU PREP

It's never a bad idea to go over how to install an Intel processor. Out of the two socket types, LGA is by far the most terrifying, and installing either Intel chips like this, or AMD's gargantuan Threadrippers, into a pinned socket like the one here is still nerve-wracking. So lift up the retention arm, raise the bracket and the cover, carefully place the processor in, aligning it with the notches on the socket and the triangle etching. Place the bracket and cover down under the screw at the bottom, secure the retention arm, the plastic cover will pop off, and breathe.

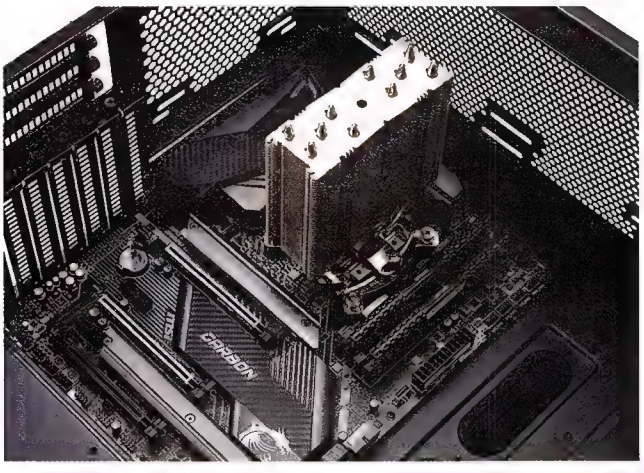
We'll also install our mounting socket for the Noctua NH-U12S. Place the backplate on, pop the spacers on top, put the metal mounting brackets in the correct orientation, then secure down with the thumb screws.



04 MINIMAL MEMORY

We've gone for less memory than we usually do, but this machine's going to be on pretty much every day from nine till five, and only running a basic OS, with a backup schedule and a few other monitoring programs on it. To that end, we've gone with two sticks of Corsair's Vengeance LPX memory at 3,000 MHz, for a grand total of 8GB. For our Core i5-10500 and storage ambitions this should be plenty, to maximise our efficiency and (laughable) cost-effectiveness. If we swap to a Threadripper chip later on, we'll swap these out for 64 or 128GB of high-spec DDR4.

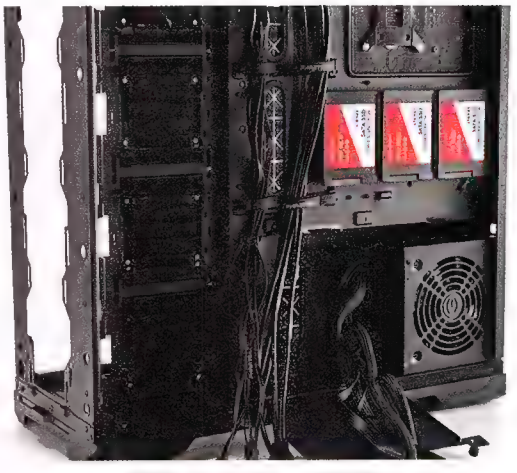
To install, lift up the tabs at both ends of the DDR4 slot, and align the memory stick with the notch in the center and the notch on the slot itself. Always install your memory in the correct channels, but it's usually every other slot for a single pair in a four-slot board.



05 FLAME ON!

It's time to get that processor ready. Apply some thermal paste to the processor (a little splodge in the middle of the chip will do; make sure it's a non-conductive paste), and position the tower over the two mounting screws in the middle of the Noctua mounting bracket. Using a screwdriver, push down and tighten each screw a bit at a time, going back and forth between the screws, so you don't place undue stress on the processor. Always do this by hand, and refrain from using a power tool.

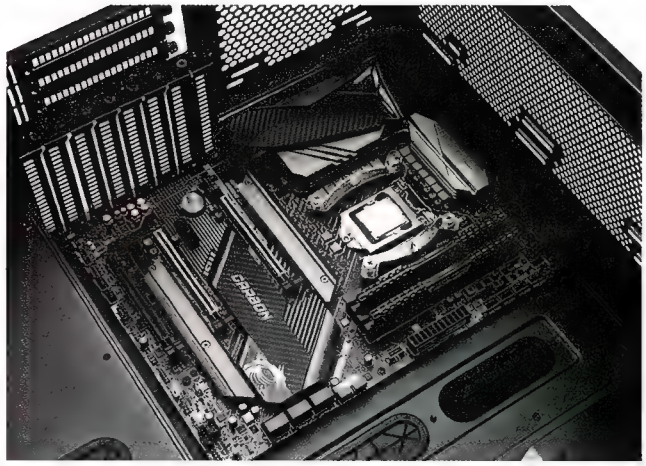
After that, install the fan into the correct position, attach the two included fan brackets to the Noctua fan, and place it on the cooler, so it's pushing air through the tower and out the rear. Plug that into the CPU fan header.



06 INSTALLING THE LOT

Let's get busy installing the key component of this build, those ridiculously expensive SSDs. We're going to be running these without redundancy, as the drives will technically be the redundancy for additional storage found within our personal work machines – at least until we reach the point where our storage gets too large, and we have to expand with more SSDs, or swap to HDDs. Remove the brackets on the back of the motherboard tray (these slide up and out), then install the drives with the Phillips screws underneath. Slot them back into position, making sure the connection points are facing down.

It's also time to get the power supply in. Use the included screws to secure it vertically. There's ventilation in the rear panel, so it's not going to choke and overheat!



07 GREEN FINGERED

It's time to install our M.2 OS drive. To do this, locate the M.2 heatsink at the bottom of the board, and remove the two Phillips-head screws from the plate. Lift the heatsink off, and identify the correct M.2 slot. Place the M.2 drive in the M.2 slot, making sure to note the orientation of the notch in the slot and the drive itself (this is to ensure that the NAND and controller chip are making contact with the heatsink), then pop the heatsink back down and secure with the same screws. Make sure you also remove the "laird" thermal pad plastic cover, before securing the heatsink back down, to maximize thermal efficiency.

08 ALL ABOARD

Now that the motherboard has been successfully prepared, it's time to get it inside the chassis. To do this, line up the motherboard with the stand-offs internally, and carefully place it down, making sure that the integrated rear I/O plate is correctly aligned with the cutout at the back of the case.

Once it's in, secure the motherboard in place, securing each corner first, with the correct screws found in Phanteks's jazzy accessory box (that came with the case).

"On the whole cable management in the Enthoo Pro 2 is a pretty seamless affair with little trouble. Phanteks has even included this cable cover next to the PSU to hide any unwanted mess."

09 CABLE CHAOS

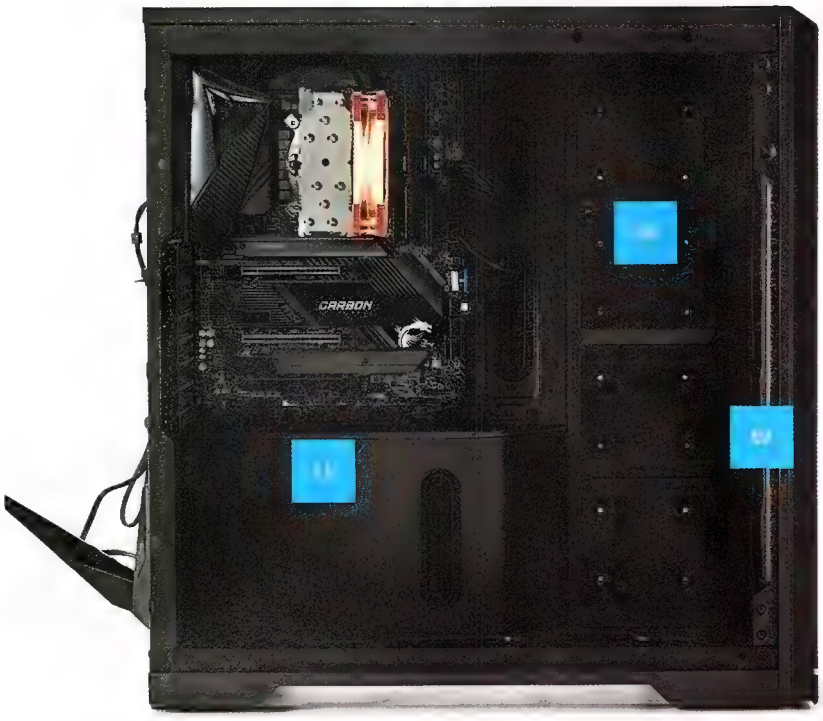
With the drives in place, it's time to plug in all those cables. You'll need the 24-pin for the motherboard, an eight-pin for the CPU socket, and a daisy-chained SATA power for our three drives spotted here. You'll also need to grab three of the SATA cables found in the motherboard box, to plug the drives directly into the board itself.

On the whole cable management in the Enthoo Pro 2 is a pretty seamless affair with little trouble. Phanteks has even included this cable cover next to the PSU to hide any unwanted mess, although it's a bit less effective, especially given all the I/O cables running up the top channel in the middle there, but the Velcro ties help keep them in place.

10 WIRELESS ASCENDANCY

Last but not least, we've decided to install our cute little magnetic Wi-Fi antenna to the back of the case. We've used one of the included Phanteks Velcro straps to tie it together, and run it up the back of the case to the ports on the motherboard itself. It's nice, simple, and looks surprisingly good.

And there you have it: One completed, ridiculously overkill NAS backup server, ready for the future plans of APC in 2021 and beyond. And boy does it look empty, but more on that in a moment.



01
There's some serious space in this build. Theoretically if you wanted you could place an ITX system here below the motherboard, to handle all of your Twitch streaming escapades.

02
Each of these plastic covers on the right of the chassis can have an SSD installed, or be replaced to allow for more HDDs.

03
We've not really taken advantage of the cooling in this chassis just yet, as our build's going to be stationary in an air-conditioned office, but the front provides plenty of intake if we do need it.

The end?

This has been a fairly simple build to put together. There haven't been any major hurdles to overcome. The biggest problem was stretching those budget ATX power supply cables up and all over the place. That budget EVGA PSU is a fine bit of kit if you're not pulling much juice from the wall, but in a case of this caliber, it does leave something to be desired when it comes to cable length.

What might be a solid upgrade path in the future (especially if this turns into a rendering station) is to install a 750W or greater Corsair RMx PSU, with a set of its pro cables as well. These things are monstrously long (so long we were forced to use them in our Dream Machine 2019 build) that they'd be an ideal candidate for the gargantuan size of this thing.

Cooling is also something that could do with an upgrade. As standard we don't have any fans drawing air into this build at all, and we could really use some intakes at the front, especially if we opt for something a bit more substantial on the processor front. For the time being, our armada of SSDs and single six-core chip won't exactly demand that much access to cool air, but if our grand schemes come to fruition it may be something we need to reconfigure later on down the line.

Outside of those minor component niggles, there's not a whole lot to report on here. The build was a fairly seamless process, as always with Phanteks chassis, cable management was a breeze, and the general build process and procedure was simple and easy to do. Nothing really got in the way, or had to be installed via some gratuitously complex masonic handshake. It all came together quite nicely. Heck, even that tinge of RGB running along the plinth isn't too gross (although we won't be configuring that in software anytime soon).

As for performance, well it's very predictable. We managed to get up at 532 MB/s on sequential read and 512 MB/s on the writes, Cinebench R15 scored 1,175 points in its multi-threaded test, and temps remained fairly concrete at just above 82C under full load in Prime95. This isn't a machine designed for gaming at all, and testing in that segment seemed a bit futile, so we opted for some additional random 4K tests instead.

As for power-draw under load, we saw a max pull of 187W after five minutes under Prime95, but the reality is this system will rarely ever hit that mark in its day-to-day life, so we're not worried. That does mean the 80+ Bronze PSU is woefully inefficient, but if we do even minor incremental hardware updates it should give us enough leeway to add extra drives, or even a low-powered GPU if the need arises.

Ultimately, this build is a pretty solid media server, and will serve its purpose well as our primary content backup going forward, and although it's obscenely expensive, we're happy with the result. ■

APC LABS BENCHMARKS

Indicates best result

	Cinebench R15 Multi	CrystalDisk QD32 Sequential	CrystalDisk QD32 Sequential	CrystalDisk QD1 Random 4K Read	CrystalDisk QD1 Random 4K Write	CPU Temp Under Load - Prime95	System Power Draw Under Load - Prime95
	Index	Read MB/s	Write MB/s	Read MB/s	Write MB/s	Degrees C	Watts
Office hours	1,175	532	512	37.42	94.38	82	187
Zero-point	1,421	3,534	3,170	58.54	148	61	472

Our zero-point consists of an Intel Core i5-10600K, 16GB of DDR4 @ 3600, a Zotac GeForce RTX 2080 Super AMP Extreme, and a 2TB Samsung 970 Evo Plus M.2 PCIe 3.0 SSD.

QUICK TIPS

APC experts solve computing problems

The *APC* team tackle problems across the spectrum of devices and software. Learn a new trick or fix you can use.

Plex transcoding

I recently opened up my Plex server running on a QNAP TS-251+ to a few friends to discover that transcoding does one of two things: If I enable hardware transcoding, the video frequently looks blocky and pixilated, but I can stream to multiple clients with no problems. But if I disable it, only one person can watch a transcoded stream without overwhelming the server. What can I do to improve the quality over hardware transcoding?
PHIL WEST

APC responds: The problem here is your QNAP's Celeron J1900 processor. Although it supports hardware transcoding through QuickSync, the processor's onboard GPU is based on the old Ivy Bridge generation of Intel HD graphics. These are known for the poor quality of their transcodes, so the only way around this is to either minimise or eliminate transcoding from your machine or upgrade your NAS.

You could opt for QNAP's TS-251D series, which is powered by a dual-core J4025/J4005 Celeron processor sporting Intel HD Graphics 600 – it's this 6th-generation chip where QuickSync finally delivers good-quality hardware-transcoded video. Or build your own NAS-like system around an embedded micro-ITX board sporting an Intel Gemini Lake processor, such as Asrock's J5040-ITX. The Pentium Silver J5040 is quicker than the J4025 Celeron processor, and sports slightly more powerful graphics (Intel UHD Graphics 605) but is similarly low-powered (just 10 watts) and fanless, making it suitable for 24/7 use with little noise.

The board's specs state that the J5040-ITX only supports up to 8GB RAM, yet Asrock's own memory compatibility chart (**https://bit.ly/MPCASrock**) reveals it can work with up to 32GB RAM. A pair of 4GB DDR4 SODIMMs costs around $60, but you may want to opt for 16GB to free up plenty of RAM for the GPU.

You'll also need a suitable mini-ITX case to house it all, and given the J5040-ITX has four onboard SATA connectors, why not source a compact model with removable drive bays, such as IN WIN IW-MS04 with 250W PSU? There's no software cost involved – while the board will run Windows, we recommend you go with Ubuntu Server, as the Windows version of Plex limits hardware transcodes to just two at any one time.

The QNAP has the slight advantage on price, coupled with the fact you'll be running a familiar operating system, but the custom build gives you the advantage of a beefier processor, plus support for more RAM and more drives.

BIOS lockout

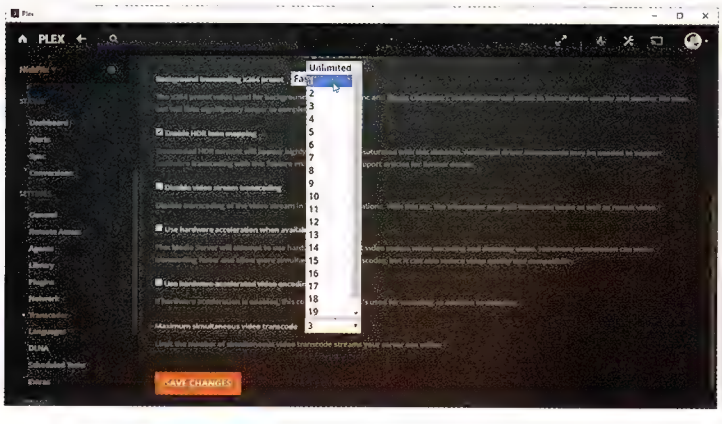
I have an Asus Q324UA laptop that was given to me by my son after he could no longer access the BIOS. Since he travels for his work, he thought it wise to set a BIOS password. No problem for a while. During some work to upgrade his desktop, he was using the laptop to go online for instructions. After completion of the project, he shut down the laptop, never to access it again. Somehow, the password is corrupt? Maybe he forgot? We have tried every combination we can think of. I also read that a Microsoft Windows update corrupted the Administrator password. Asus declined to comment on that.

Asus Support tells me there is no "back door." Asus factory repair will replace the motherboard, but it won't be cheap. It appears the BIOS on this machine is on an EPROM and there's no way to change it. This seems to be the consensus online.

Do you have a remedy? Can the BIOS be reset, or do I now have an expensive paperweight?
JIM ROEBUCK

APC responds: Your son has learned a valuable lesson about the shortcomings of setting a BIOS password, Jim! They can stop working for no logical reason, and ultimately do little to protect your machine – a determined thief could simply remove the hard drive and access any sensitive data directly. A better way to secure a laptop going forward is by using BitLocker to encrypt the entire drive, which protects the drive contents as well as access to Windows. Store the password somewhere safe – try a secure note in Bitwarden for example – so it's never forgotten.

There's one thing Asus laptop owners can try to bypass the BIOS password, depending on your laptop model. First, when the password prompt appears, try pressing Alt-R, which should bring up an "Enter Rescue password" box with the date on it in YYYY/MM/DD format. Visit **www.biosbug.com/asus** on a working PC and enter that date into the box, then click "Send Request." After a short pause, a series of letters and numbers will appear, which you should enter as the rescue password



Hardware transcoding works best with later-generation graphics.

to hopefully unlock the laptop. Then, press F2 to go into the BIOS to navigate to the "Security" tab and remove or change the password.

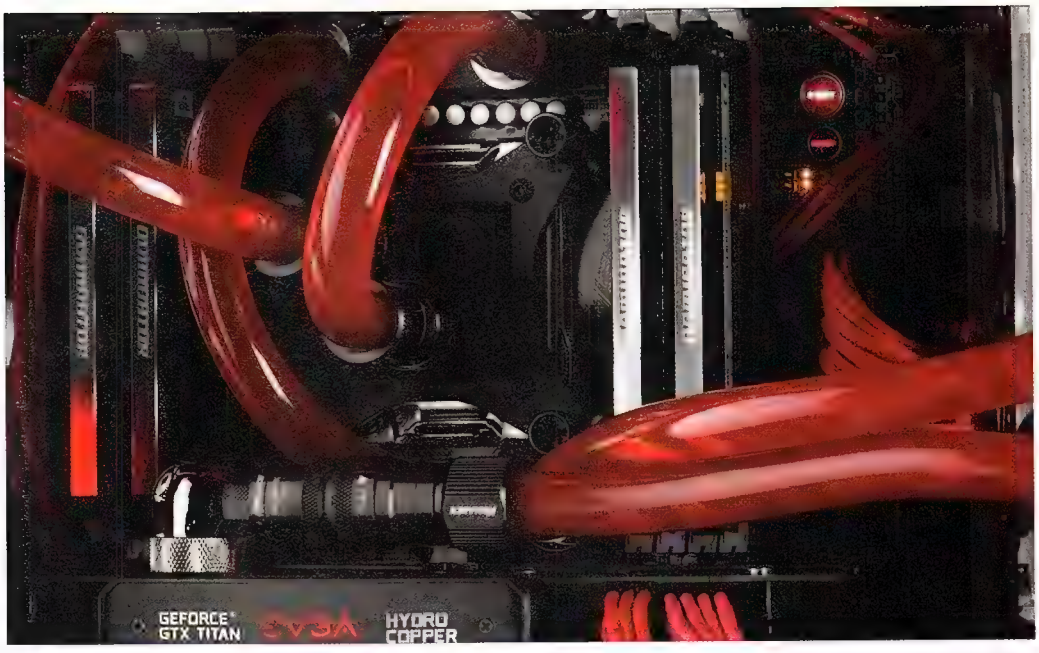
Jim had already tried this workaround – this particular Asus model didn't support the recovery password option. Ultimately there appears to be no way to reset the BIOS to remove the password, but we found a cheaper alternative to Asus's solution: purchase a refurbished motherboard for around $300 on **www.ebay.com** (search "Asus Q324UA Laptop Motherboard") and then swap out the old motherboard for new, following iFixit's guide (**https://bit.ly/MPCifixit**). It's an expensive fix, but it's cheaper than replacing an otherwise-serviceable laptop.

CPU fan error

Any idea why this happens? I have a water-cooled system (HydroLux Level 3) that keeps my system (Asus ROG Rampage V) pretty much at a consistent 25 degrees Celsius, yet it's started throwing up a CPU fan error when I switch on, halting the boot sequence. If I press Ctrl-Alt-Del to restart, then it launches Windows fine.
D DOMINGUEZ

APC responds: This is quite common with water-cooled systems on mobos that don't have a specific water pump cooler header on them. When you plug your water pump into the CPU fan header, it's unable to provide enough sustained power to run the pump at full speed, which triggers the error. This is a false positive, and you can either continue to ignore it or enter your BIOS to instruct your PC to ignore the CPU fan speed in its monitoring section, and the error will vanish.

In the case of your Asus ROG Rampage V, browse to "Monitor > CPU Q-Fan Control (Auto)" and look for a "CPU Fan Speed Low Limit" setting – change this to "Ignore," which should stop the alert appearing on startup. Some Asus ROG Rampage boards provide a W_PUMP header, so if you own one of these boards, you should power down your PC and check that all the fan connectors are plugged securely into the correct sockets. If you've got a regular fan plugged into the CPU_Fan header, check this is running OK as it'll be responsible for the error – it may need cleaning out, or may be a symptom that the fan's starting to fail as it can't spin fast enough to satisfy the BIOS.



Water pumps can trigger errors if plugged into the CPU_FAN header.

USB mouse disconnects

I'm having some problems with the USB ports on the back of my system into which are plugged my mouse and keyboard. While casually playing some video games, both the mouse and the keyboard disconnect, even though they are still connected to the back of the motherboard, and the only way to get it working is to do a full reset of my computer. I'm running a Ryzen 7 3700X on an Asus ROG Strix B450-F Gaming mobo, 16GB RAM and 500GB M.2 drive. Can you explain the cause of the disconnect?
CAKEGAMER21

APC responds: There are several questions here that need answering: First, are you hearing the classic USB disconnect sound indicating the keyboard and mouse are being disconnected, or do they simply stop working? If it's the latter, the problem may be Windows locking up, or it may be linked to the game. Does it happen elsewhere on your system?

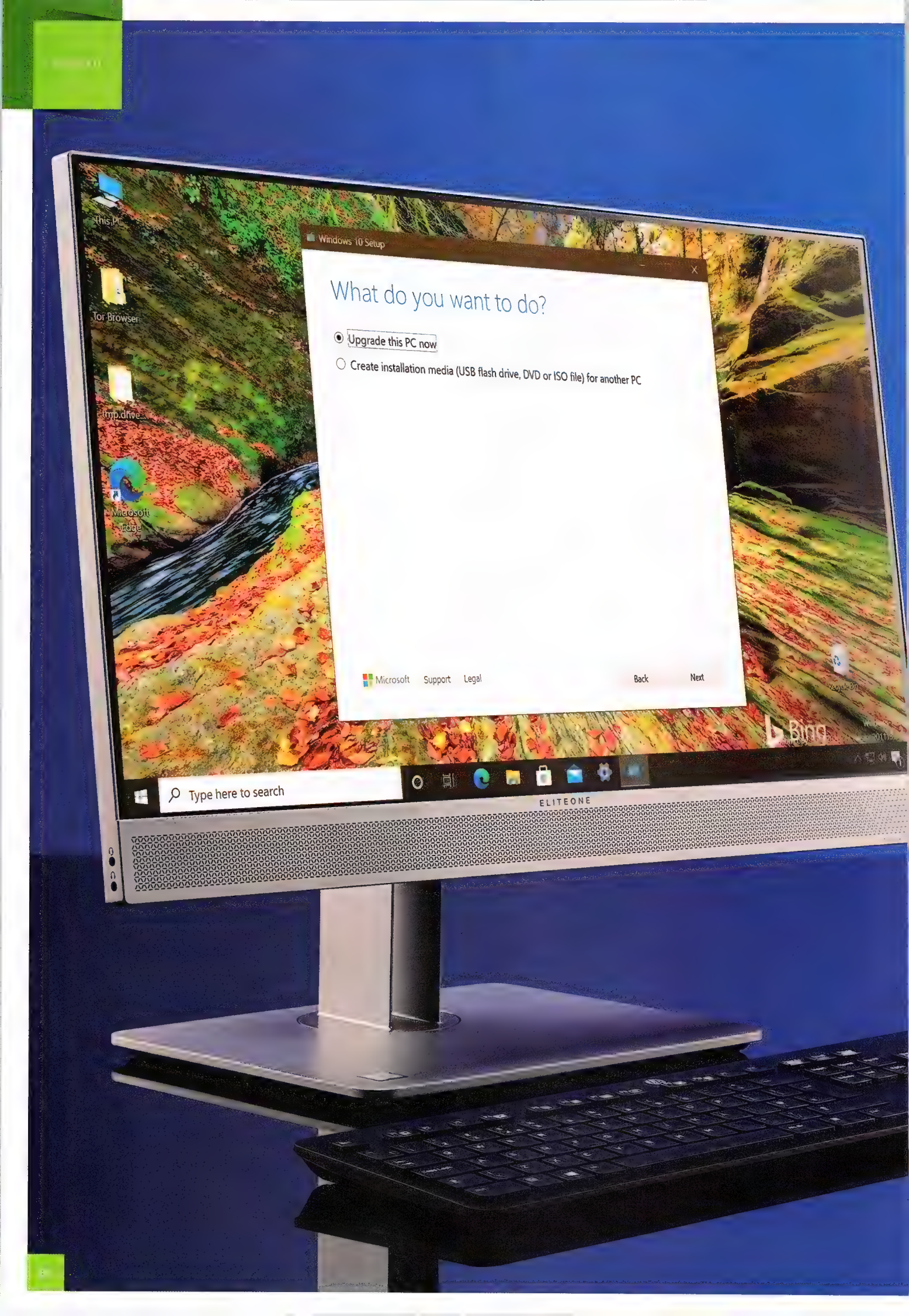
If the problem is an intermittent one with no obvious reasons behind it, then it may be a hardware issue. You could try a different keyboard and mouse in your PC, but the chances of both failing in the same way seem remote. Instead, try plugging them into different ports to see if that fixes the problem; if it does, the ports in question may be failing. Given the ROG Strix B450-F has plenty to spare (eight at the back of the motherboard alone), this workaround on its own could be acceptable.

If the problem affects all USB ports, make sure your UEFI/BIOS is fully up to date (choose the non-beta version), as well as your motherboard chipset drivers. Next, try disabling the "USB Selective Suspend" option – press Win-R, type "powercfg.cpl" and hit Enter. Click "Change plan settings""next to the selected plan, followed by "Change advanced power settings." Expand "USB settings > USB selective suspend setting," and set it to "Disabled".

If you're still plagued by the disconnects, open Device Manager and expand the "Universal Serial Bus" controllers section – double-click each USB Root Hub in turn, switch to the "Power Management" tab and untick "Allow the computer to turn off this device to save power," before clicking "OK." Double-check the options haven't been ticked for your mouse and keyboard too (although they're more likely to have been grayed out and the device allowed to wake your PC).

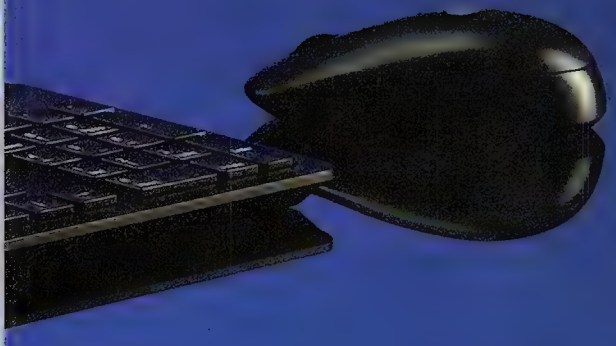
Still no luck? There's the possibility of Registry corruption, which results in duplicate entries for your mouse and/or keyboard being created in Device Manager. You can verify this is the case using Nirsoft's free USBDeview tool (**www.nirsoft.net/utils/usb_devices_view.html**) – download, extract, and run the x64 version. If your mouse appears multiple times in this list, removing all the entries then rebooting may temporarily solve the problem.

Finally, if the problem only occurs while gaming, it may indicate that your PSU is struggling to meet the demands being made of it when your system is under load. Now may be a good time to consider upgrading or replacing it. But before doing so, if the problem only occurs in one game, it's likely that the problem is caused by that, so visit user forums and support pages to see if others have reported similar problems.


Windows 10 Setup
What do you want to do?
Upgrade this PC now
Create installation media (USB flash drive, DVD or ISO file) for another PC
Microsoft
Support
Legal
Back
Next
Tor Browser
Type here to search
ELITEONE

The ultimate guide to reinstalling Windows

Ian Evenden takes on possibly the most boring yet essential task it's possible to carry out on your PC.



There are many reasons why you may want to reinstall Windows on your PC. The most common is hardware change – a fresh installation will often run better than one that was previously installed on a different PC, so if you're swapping out motherboards and CPUs, it's worth doing it to squeeze the maximum performance out of your new hardware.

Then there are reasons of maintenance: Perhaps something has gone wrong deep inside the operating system, a botched driver installation or damage from some malicious software affecting how your PC runs. Maybe Windows is just unbearably slow, and you don't know why.

All of these are good reasons to reinstall Windows, and it's a quick and easy process these days. And while a complete reinstall is your nuclear option, wiping away all traces of what came before, there are other options – Reset and Refresh – that can help you out too, saving your documents if you're not so hot on the backup regime.

Here is not a discussion of why you should reinstall the OS – you'll know when the time is right – but how to do it. While there are different methods, they all rely on being able to download the OS from Microsoft's servers, so you'll need a PC with an internet connection. Do not let your PC get so bad that you can't fire up a web browser!

Getting stuck in

If you need to completely wipe your system and start again, there's a bit of work to do first. You'll need a Windows PC, a USB stick that's 8GB or larger (or a blank DVD-R in a writable drive), and the Media Creation tool from **www.microsoft.com/en-us/software-download/windows10**. Run it, choose "Create Installation Media..." and follow the prompts.

When it comes to a full reinstall of Windows 10, you will need your product key, or at least a digital license linked to your Microsoft account. Check "Settings > Update & Security > Activation." If you see the message "Windows is activated with a digital licence," this means you're digitally signed, but you should link that license to your Microsoft account in case of installation issues or future hardware changes. Head to "Settings > Accounts > Your Info," sign in with your Microsoft account details, and the message should change to "Windows is activated with a digital licence associated with your Microsoft account."

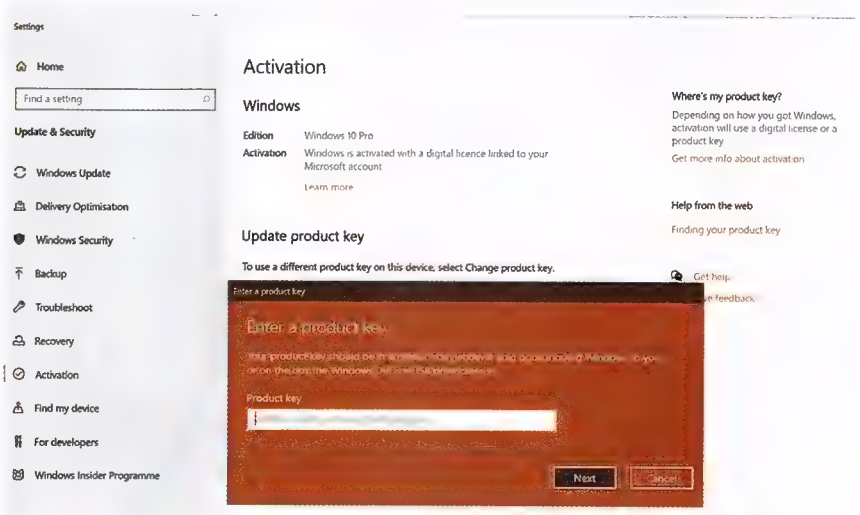
It's also worth making a note of any product keys for your software – you can create a list of all the programs installed on your PC with a Powershell command. Run it as an administrator, and type:

```
Get-ItemProperty HKLM:\Software\Wow6432Node\Microsoft\Windows\CurrentVersion\Uninstall\* | Select-Object DisplayName, DisplayVersion, Publisher, InstallDate | Format-Table -AutoSize → C:\software.txt
```

This creates a file called software.txt in the root of your C drive with a list of all your installed programs, so when you come to reinstall them you won't forget one.

Third-party freeware app ProduKey (**www.nirsoft.net**) will dig out your Windows product key and those for many other programs. However, both Windows 10 and Malwarebytes flag it as potentially harmful, and Windows refuses to run it, so we couldn't possibly tell you to go to "Windows Security" in "Settings," then choose "App and Browser Control" to allow it to run anyway. That's at your own risk, obviously. Also, consider using a password manager to safely hold all your passwords, so you don't need to worry about any that are stored on your PC getting lost. We like Bitwarden, as it's open source and free.

The last thing to do, if you've not been doing it all along, is to get backed up. While it's possible to do an upgrade in place of Windows 10, retaining all your documents but replacing the OS and losing your apps, it's not a 100-percent foolproof process. Take a backup just in case. At the very least, shove all your documents onto an external drive, as losing precious digital memories can be heartbreaking.



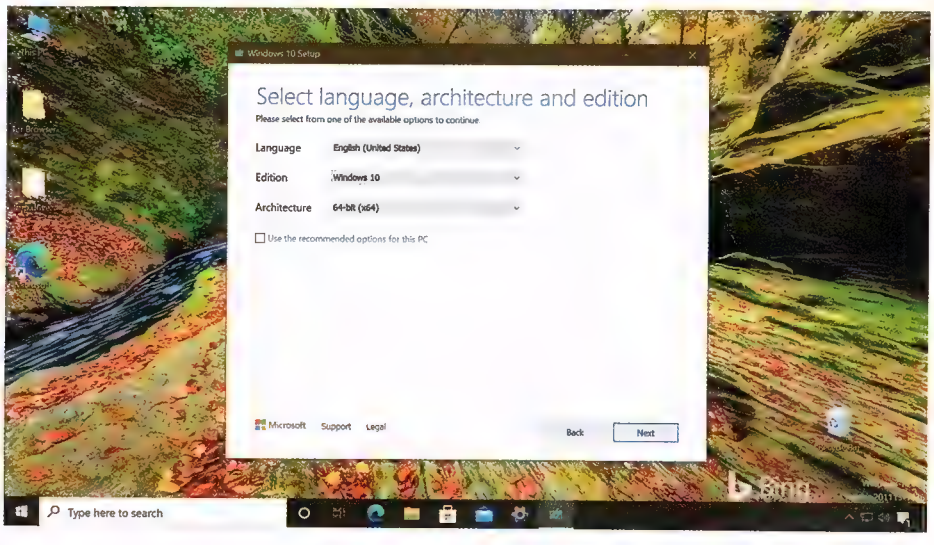
Enter the Windows product key to link that license to your account.

In medias res

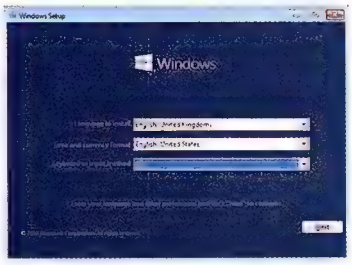
By now, the Media Creation tool should have downloaded Windows 10 and be creating your installation media. The process is completely automatic, so you don't have to do anything except watch the progress percentage get higher and higher. Eventually you'll get a message saying that your USB flash drive is ready, and a "Finish" button. Click it, and the installer cleans up after itself and exits. You're left with a bootable USB drive that you can use in a few different ways.

Firstly, you can use it to perform an upgrade to your current machine. Double-click the Setup file on your installation medium, and you'll be taken to the Windows 10 set-up app, which will install the OS over the top of whatever you're running. You've made your install medium from the latest version, but it checks for updates anyway, before asking you what you'd like to keep. This is important, as it determines the extent of the cleansing that's about to happen to your system.

Choose to "Keep personal files and apps" if you want to come back to a PC that hopefully functions better than before, but looks much the same and still has all the same apps installed on it. "Keep personal files only" is a deeper wipe that takes out all your apps but retains your documents. "Nothing" is the scorched-earth option – a good choice if you're


Windows 10 Setup
Select language, architecture and edition
Please select from one of the available options to continue
Language English (United States)
Edition Windows 10
Architecture 64-bit (x64)
Use the recommended options for this PC
Microsoft Support Legal
Back
Next
Type here to search

Use the Media Creation tool to create installation media for Windows 10.



Going through the Windows setup gives you the chance to select language, etc.

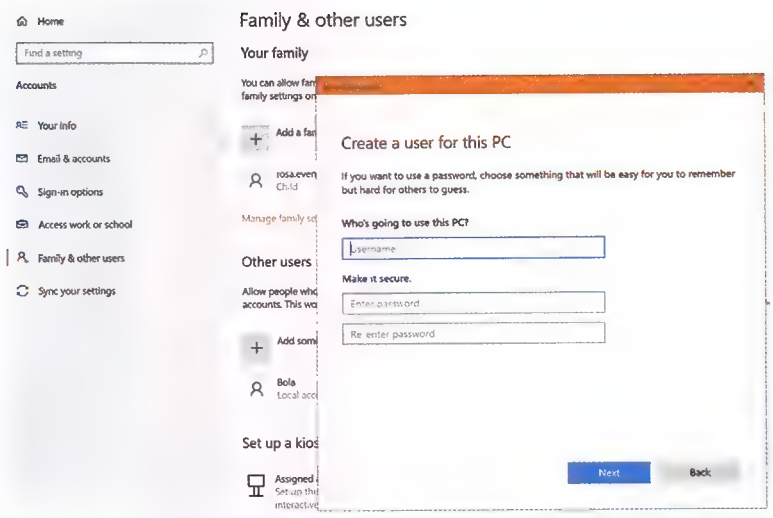
reinstalling before selling your PC. It leaves absolutely nothing behind but the OS.

Whichever of these you click, there's a brief pause while it checks for yet more updates – presumably in case Microsoft snuck one out while you were pondering what to keep – before giving you the chance to review your choices one last time. Pressing the "Install" button from the "Ready to install" screen begins a process there's no way back from.

The other thing you can do with the installation medium you've prepared is to stick it into another PC and use it to upgrade that machine. While the USB stick or DVD you prepared is bootable, you'll almost certainly need to tinker in the BIOS of the target machine to make sure it looks for another bootable drive before booting from its C drive. Getting into the BIOS is usually a matter of hammering Del or F1 while it POSTs, but different manufacturers make their BIOSes differently, so we have little advice to offer on changing the boot order. Just have fun poking around in there, and try not to break anything.

Reset or rewind

A reset is an easier way to do all we've done above, just without creating the useful installation medium. Resetting only gives you two of the options you got with an in-place upgrade: Keep your files, or keep nothing. There's no "keep apps" option here, so if that's important to you, you'll need to do the reinstall through the installation medium method. You're offered the choice of a cloud download of the most recent version of Windows 10, or using the version already on your PC. We'd recommend the cloud download unless your PC is not online or using dial-up. It's going to download more than 4GB, however. Note that if you've recently updated, you won't be able to roll back that update after



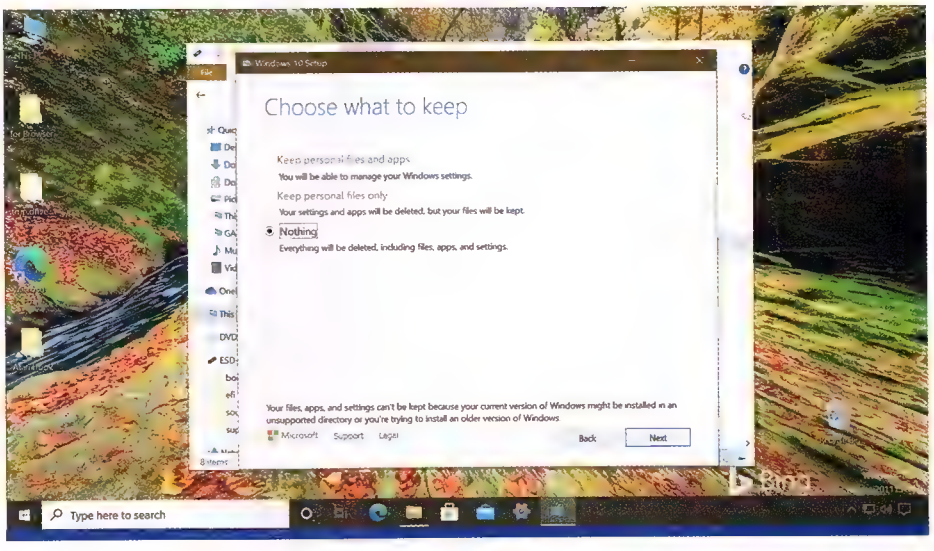
Local accounts

Creating a local account, as opposed to a synced Microsoft account tied to an email address, used to be the default way of accessing an operating system. Microsoft is trying to change all that with Windows 10, however, and is pushing the Microsoft account hard, to the extent of removing the option to create a local account during installation. This makes sense, as the account you made during setup is the PC's admin account, and so needs to be secure.

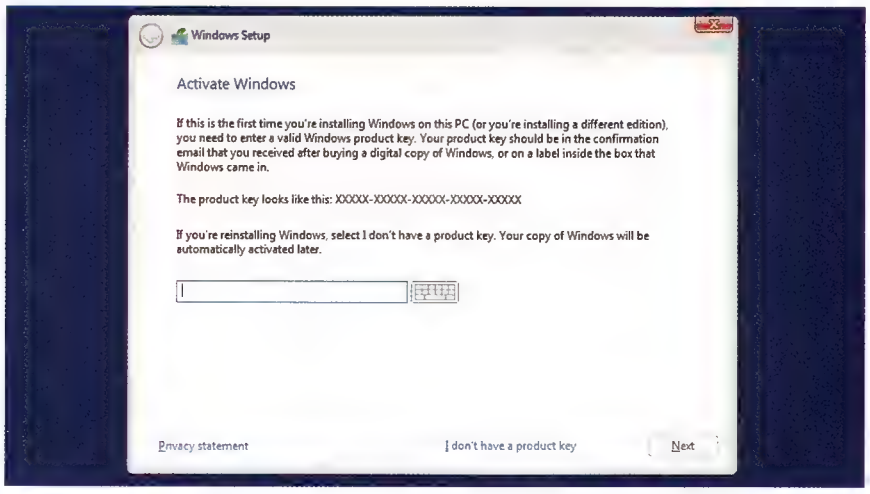
The option is still there though, albeit buried. Open "Settings > Accounts > Family & other users," and choose "Add someone else to this PC." Click "I don't have this person's sign-in information" in the window that pops up, then "Add a user without a Microsoft account" in the next one. Finally, you'll be able to add a user account to the computer without tying it to a Microsoft account. You will be asked for the name and a password, but only the name is needed – it's perfectly possible to create an insecure password-less account, and also possible to change its account type from standard user to admin without adding a password. We really, really don't suggest you do this, as it leaves a large security hole that is easily exploited.

Local accounts can be converted to Microsoft accounts later from the same screen, while the main admin account you created during installation can be converted to a local account from "Settings > Accounts > Your info."

"The other thing you can do with the installation medium you've prepared is to stick it into another PC and use it to upgrade that machine."


Choose what to keep
Keep personal files and apps
You will be able to manage your Windows settings.
Keep personal files only
Your settings and apps will be deleted, but your files will be kept.
Nothing
Everything will be deleted, including files, apps, and settings.
Your files, apps, and settings can't be kept because your current version of Windows might be installed in an unsupported directory or you're trying to install an older version of Windows
Microsoft
Support
Legal
Back
Next
Type here to search

You can select how much of your current system you wish to keep.


Windows Setup
Activate Windows
If this is the first time you're installing Windows on this PC (or you're installing a different edition), you need to enter a valid Windows product key. Your product key should be in the confirmation email that you received after buying a digital copy of Windows, or on a label inside the box that Windows came in.
The product key looks like this: XXXXX-XXXXX-XXXXX-XXXXX-XXXXX
If you're reinstalling Windows, select I don't have a product key. Your copy of Windows will be automatically activated later.
Privacy statement
I don't have a product key
Next

Windows activation

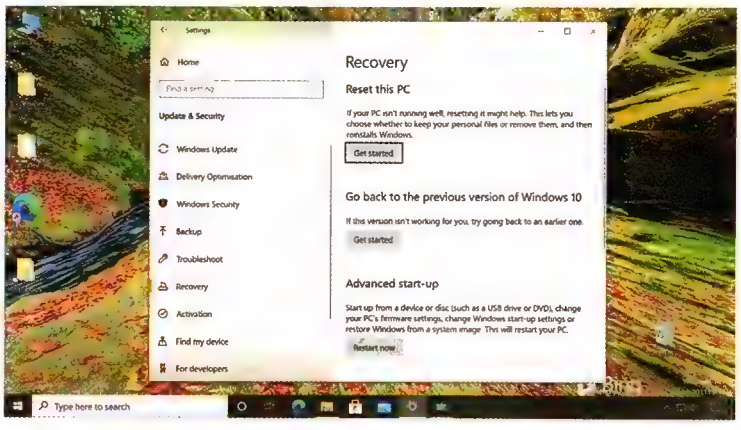
Windows activation is a kind of super fun thing that, if it goes wrong, shows you really unhelpful messages and gets you to phone Microsoft support. However, if you didn't have a licence key to type in during installation, and this is a reinstallation onto a system that's been activated and tied to a Microsoft account before, there is one thing you can do. On the "Settings > Update & Security > Activation" page, click "Troubleshoot." You must be logged into your Microsoft account for this to work, and it needs to be the same one that was previously activated. The troubleshooter thinks for a while, then gives you a list of the Windows activations registered to your account. Click the one you want to use, and the "I've recently changed hardware" box if necessary, and activation will often complete.

If you've purchased Windows online, your product key can be found in the confirmation email. Sometimes it's printed on a sticker fixed to the bottom of laptops.

However, not activating Windows – despite activating being unequivocally the right thing to do – doesn't really limit its use. You get a watermark in the bottom right of the screen saying it isn't activated, and you're prevented from changing the wallpaper away from the blue Windows logo using "Personalise" (but can still change it with right-click > Set as desktop background). Otherwise, it doesn't nag you. This may change, but for now there's little penalty to not activating, apart from the disintegration of your soul. You can pay to activate at any time, should the guilt become too much.

you've finished the reset. This can be crucial if it's a recent update that's causing you a problem. Hit "Next," and you'll be offered one last chance to review your choices, before hitting the "Reset" button and letting it do its thing.

If you've recently updated your Windows 10 installation to the latest version, and feel it's not working out or could do with some more development time, you can roll it back. You can do this from two places, depending on the state your PC is in. Either in "Settings > Recovery" (you have to be within 10 days of the offending update's installation, otherwise the option isn't available), or by booting from an install medium and choosing "Repair your computer" from the "Install now" screen.



There are several options to reset or recover Windows.

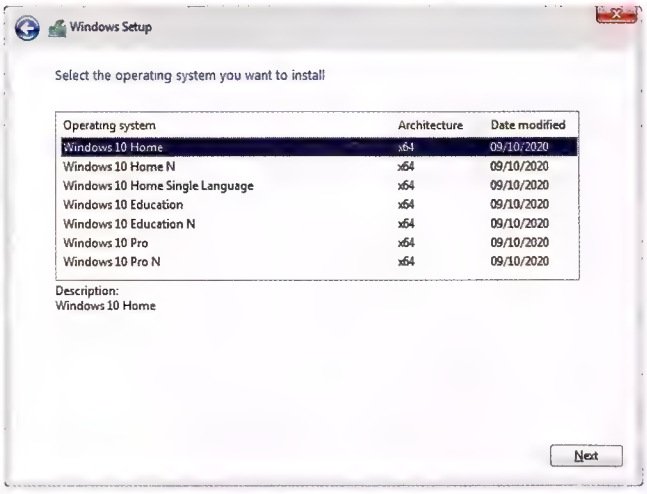
Clicking this option gets you some interesting new toys to play with. You can restore from a Restore Point, should you have one saved on your PC, and you can reinstall Windows from a specific disk image, or use Startup Repair to fix problems that prevent Windows from loading. But we came here for uninstalling problem updates, and the option is right there on the left. Click it, and you get further choices – the last quality update, or the last feature update. Quality updates tend to be bug fixes or security patches, while feature updates are the bigger releases, such as the October 2020 update. Select the option you think is causing the problem, and hit the button to uninstall. There's still a chance it won't be able to roll it back, especially if it's been installed for a while, but it's worth a try.

Rebuild, remake

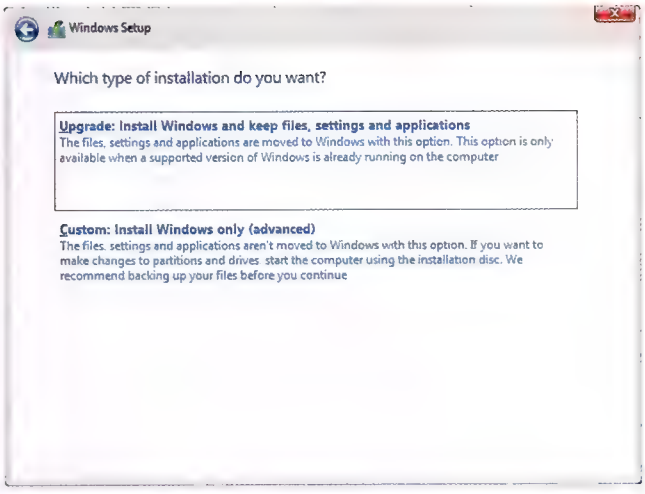
Back to our reinstall, and note we're using the October 2020 update version of Windows 10 Home, as that's what was available at the time of writing. If you're reading this in the future, 1) Hello! How are the flying cars? 2) Your experience of installing Windows 12 onto a quantum PCIe 6.2 SSD may be different.

Once you've booted from the USB drive, you're presented with a screen that has a big, friendly "Install" button, and the much smaller repair option. Hit "Install," and you'll be prompted to choose your PC's language and keyboard layout. The next screen is for activation. If you have it to hand, you can put in your product key now and click "Next," otherwise click "I don't have a product key" at the bottom. Both have the same effect – the reinstallation continues – but if you choose the latter you'll need to activate Windows later.

At the next screen, choose which version of the OS you'd like to install. This should exactly match the version your product key is for, or the version you intend to buy later. Most of the time it'll be Home, although the Pro version is often available cheap online and gives access to interesting features, such as the built-in hypervisor, or



Choose the Windows version that exactly matches your product key.


Windows Setup
Which type of installation do you want?
Upgrade: Install Windows and keep files, settings and applications
The files, settings and applications are moved to Windows with this option. This option is only available when a supported version of Windows is already running on the computer
Custom: Install Windows only (advanced)
The files, settings and applications aren't moved to Windows with this option. If you want to make changes to partitions and drives, start the computer using the installation disc. We recommend backing up your files before you continue

Choosing "Upgrade" will begin the installation process.

BitLocker encryption. The "N" versions of Windows don't come with certain apps such as Skype, Windows Media Player and the voice recorder. The N versions are only for sale in Europe, while a KN version is for South Korea, and they exist purely for tedious legal reasons involving court rulings from 2004 (2005 in South Korea). If you see either of these versions, feel free to ignore them. Even if you're in one of the affected jurisdictions, you don't have to install an "N" version – the usual version is available too.

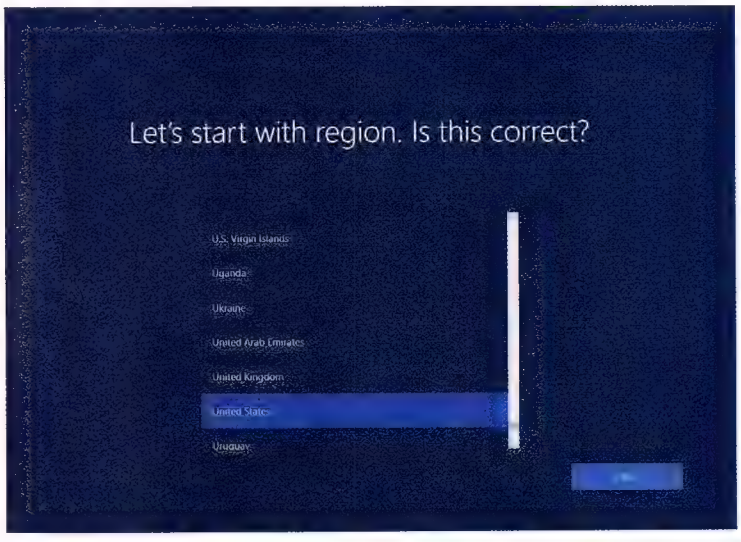
Pick your version, hit "Next," accept the license terms, and you're faced with another choice: Upgrade (only works if there's already a copy of Windows installed on the PC, and keeps your files, settings, and applications) or "Custom." The latter is for machines without an installed OS, or if you want a completely destructive reinstall. It lets you format the disk partition you'll be installing onto, and completely sets up your PC as if it was new. If you choose "Custom," you are happy with the way your drives are set up and have clicked on a partition to receive the OS, the very next screen once you press "Next" begins copying files for the installation. The only way back from here is to use the red X button to cancel, and begin the process all over again.

Hit "Next," however, and you might as well sit back and have a coffee. The installation process from a USB drive is fast and doesn't call on you until it's time to create an account and sign in for the first time. It's also relatively fast, especially if you can recall installing Windows XP from CD, or 3.1 from floppies. It restarts a few times, and it's not long before you're facing the terrifying words: "Hi, I'm Cortana, and I'm here to help." Ignore her, unless you need assistive technology, and go on to select your region and keyboard layout.

You'll be left waiting a few times during this setup process, but the next screen asks you to create an account. It wants an email address, Skype ID, or phone number to create a Microsoft account. Where once you could create a local account and access the OS the old-fashioned way, now you have to sign into a Microsoft account the first time you use it. You can create a local account later – see "Local Accounts" on page 87. Give your MS account address and password, and you'll be prompted to choose a PIN for Windows Hello.

Next you're into privacy settings. If you're not sure what to choose when confronted with the wall of privacy settings, then it pays to err on the side of caution. If you've locked off something you later decide you can use, then it's possible to change a setting later. The only ones we leave on are "Find My Device," and "Location Services," just in case we lose our PC somewhere. Next, you're asked to connect an Android phone to see your texts and notifications appear as Windows notifications, but you can hit the "Do it later" button to skip this step.

Next is OneDrive. There's a button in the bottom-left corner of the screen that lets you skip this step – "Only save files to this PC." Otherwise, "Next" takes you to a screen activating Cortana. You can "Accept," or say "Not Now." Eventually, after a wait of a few minutes, you'll get your desktop with an advert for Edge in the corner. The first thing to do is to change the desktop resolution to that of your monitor, and then the rest is up to you (although Ninite and driver and chipset installation is a good start!).



Choose your region and keyboard layout following a reinstall.

MAC

Customise Control Centre

How to add features to Control Centre in Big Sur.

IT WILL TAKE
15 minutes
YOU WILL LEARN
How to customise Control Centre in Big Sur
YOU'LL NEED
macOS 11

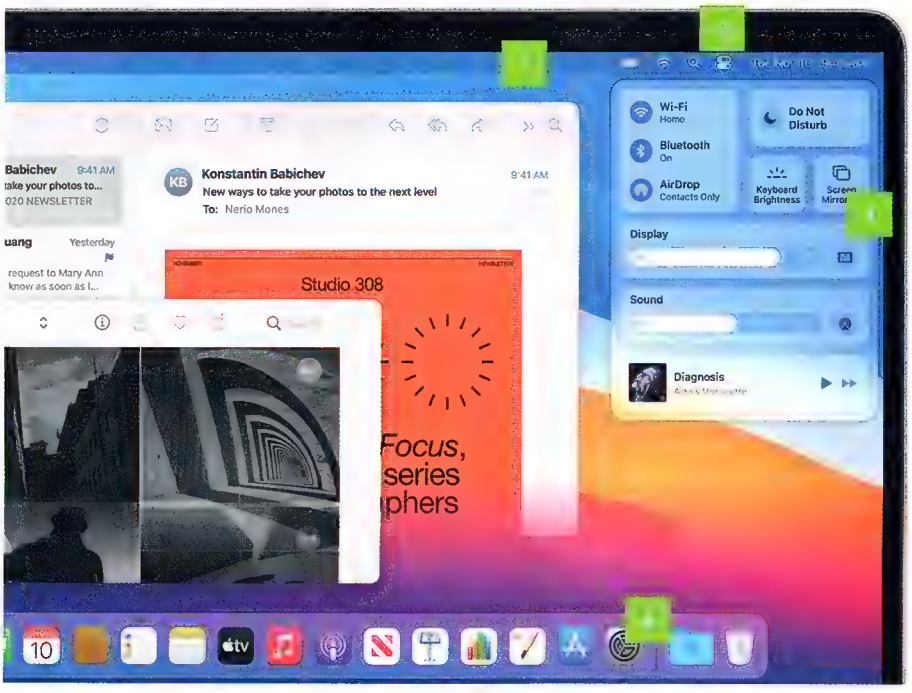
The menu bar at the top of the Mac screen has been a fixture of the macOS for decades. The handy bar provides a convenient set of tools in the top-right corner of the screen, allowing you to quickly access and control key features on your Mac, such as Wi-Fi settings, Bluetooth and sound.

But, over the years, that little corner of the menu bar has become rather cluttered, so Big Sur's introduction of the new Control Centre – borrowed, of course, from the iPhone and iPad – represents one of the biggest changes to the Mac's interface in years. By default, there's a fixed set of nine specific features that will always be visible in Control Centre. This means that you can now tidy up the menu bar by removing those particular features from there, and keep them inside the Control Centre instead. It's worth noting that those nine features can't be removed, but you can add more features to Control Centre – such as Fast User Switching, Battery and Accessibility controls – making it much quicker and easier to get your Mac set up the way you like it. CARRIE MARSHALL

EXPLAINED... Control Centre in macOS 11

1 KEEP VISIBLE
You can drag and drop items from the Control Centre into the menu bar, so that they're always visible.

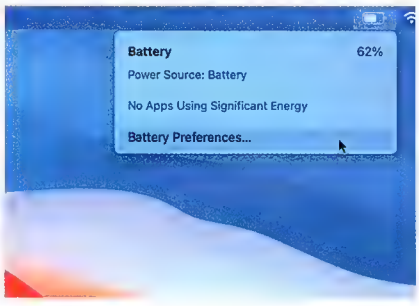
2 CLICK CONTROL
As this is not a touchscreen, you need to click this icon in the menu bar to open Control Centre.



3 POWER OF NINE
By default, the Control Centre contains a group of nine features; these can't be removed but you can add more.

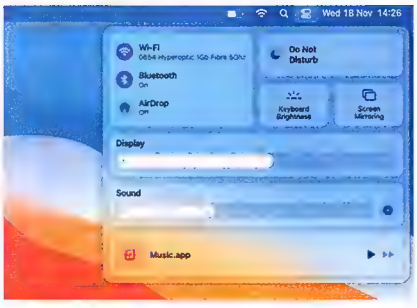
4 PREFERENCES
The old Dock panel in System Prefs has been updated, with new features for modifying Control Centre.

HOW TO Make the most of Control Centre



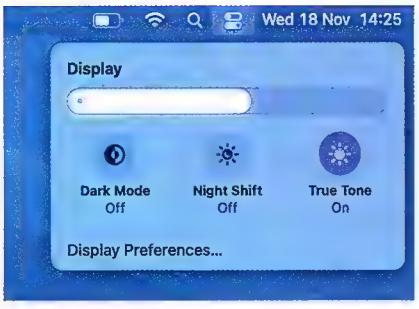
01 MENU BAR

The menu bar in Big Sur still works the way it always has, with icons representing features such as battery power and Wi-Fi. Click on any icon and you'll see a pull-down menu with additional settings for that particular feature.



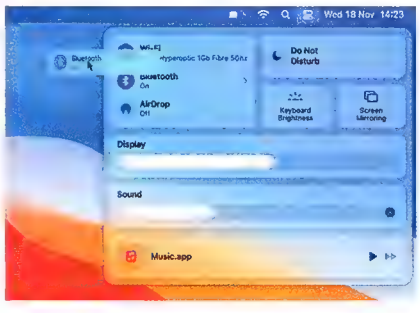
02 CONTROL CENTRE

There is one new icon in the menu bar, though, which looks like a little set of switches. Click on this icon and you'll see the new iOS-style Control Centre, which contains a much larger group of controls and features.



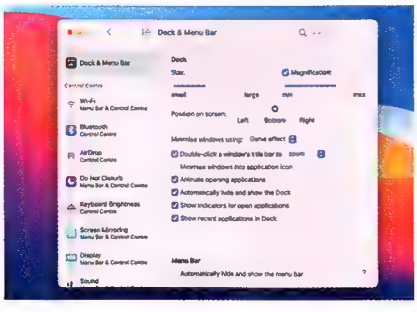
03 CHANGING SETTINGS

You can click on any of these features to see more detailed settings. Clicking on Display will show options, such as Dark Mode and Night Shift, and there will also be an option to open System Preferences for that feature too.



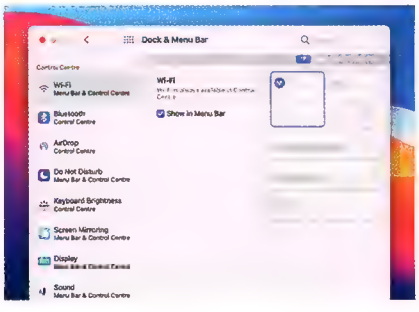
04 DRAG AND DROP

You can also use Control Centre to quickly customise the menu bar. Click and hold on any feature in Control Centre and you can then drag and drop that feature up into the menu bar so that it remains visible all the time.



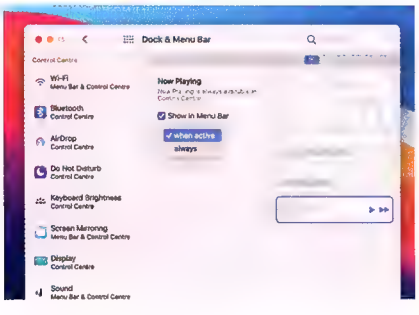
05 SYSTEM PREFERENCES

Now let's dig a little deeper. If you open System Preferences and select Dock & Menu Bar, you'll see a scrolling list on the left-hand side of this panel with additional features that can be used to modify Control Centre.



06 ALWAYS ON

Scroll down that list a little, and the first thing you'll see is the set of nine features that are fixed, and will always appear in Control Centre. The list starts with Wi-Fi and ends with the Now Playing media controls.

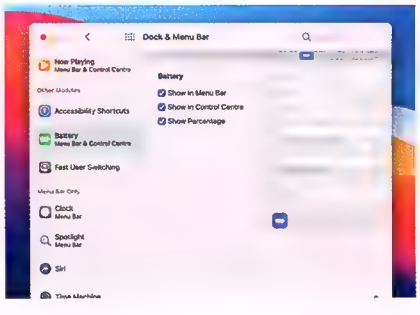


07 NOW PLAYING

These features always appear in Control Centre, but you can also set them to appear in the menu bar at specific times when they're needed. Click on Now Playing in the list. Click Show In Menu Bar and select 'when active'.

08 NOW NOT PLAYING

The Now Playing icon will now appear in the menu bar – but only when you're playing music or video, such as this Kate Bush album in the Music app. When you quit the Music app, the Now Playing icon will just disappear again.

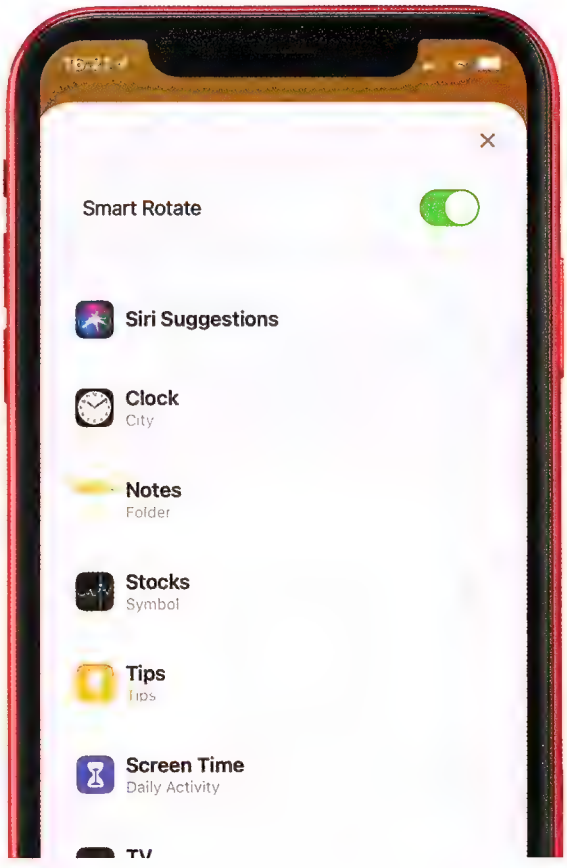


09 EXTRA OPTIONS

Scroll a little further down that list of features, and you'll see a number of other useful options that you can add to either the Control Centre or the menu bar, including Fast User Switching, Battery and Siri.

JARGON BUSTER
Jiggle mode is the state your iOS device enters when you tap and hold an app or blank area of screen. Apps 'jiggle' and can be moved or deleted.

GENIUS TIP!
Like other widgets, Smart Stacks can be dragged to the Today View. That lets you create a daily control centre without clogging up the Home screen.



iOS

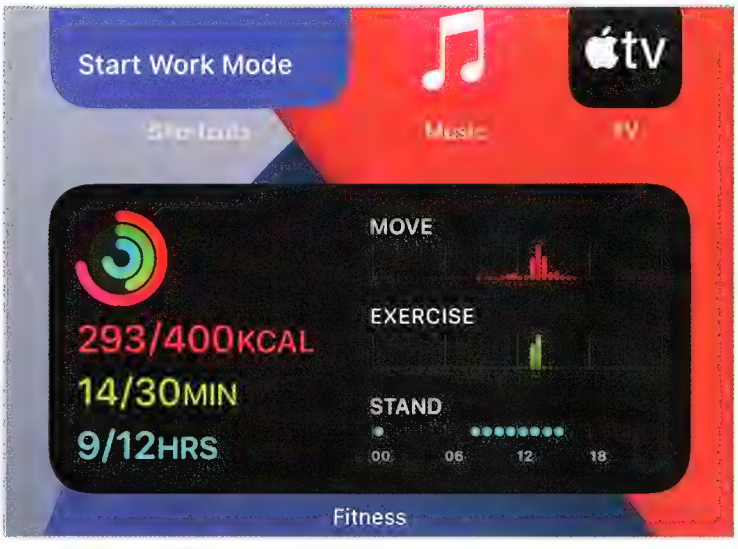
Smart Stacks in iOS 14

Spruce up your Home screen with this clever little widget.

Apple has brought a long-overdue revamp to its mobile devices in the form of iOS 14. For the first time, you no longer have to put up with overflowing apps and countless sheets to flick through just to find the app you want – everything can be stored in the App Library instead. And if you fancy having the latest weather and news stories greet you when you unlock your phone, you can thanks to the introduction of widgets.

But you do not have to stop with plain old widgets – Apple has added more depth in the form of Smart Stacks. These work a bit like widget folders, with each Smart Stack containing multiple widgets that you can scroll through until you find the one you need. Even better, your device can present the right widgets at the right time at the top of a Smart Stack, based on your usage habits throughout the day. It is a great way to save space on your Home screen without losing functionality.

IT WILL TAKE
5 minutes
YOU WILL LEARN
How to build and edit your own Smart Stacks in iOS 14
YOU'LL NEED
iOS 14

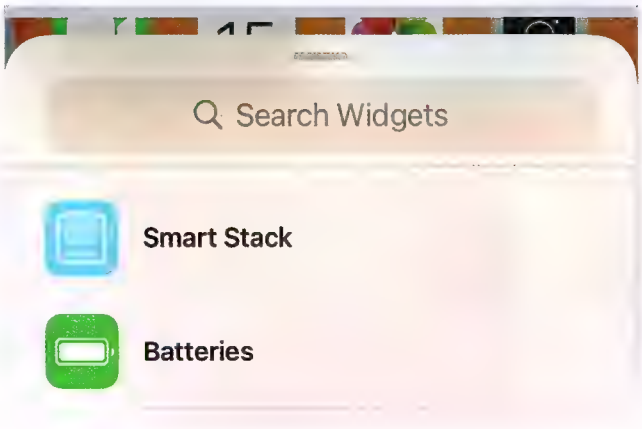


Smart Stacks can add some extra flair to your Home screen. They come in a variety of sizes, and you can add or remove widgets as you please.

Beyond the basics

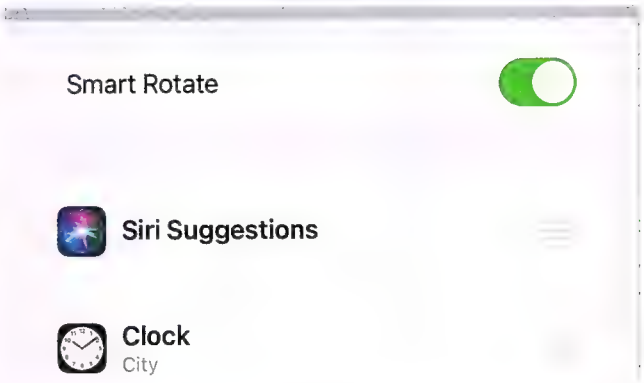
In this tutorial, we will guide you through the process of creating, editing, and managing Smart Stacks in iOS 14. Apple has made the whole process very easy to learn, but there is plenty of depth and extra customisation available should you wish to go beyond the basics. We will cover all that and more here, helping you master this clever new feature in Apple's latest version of iOS.

HOW TO Create and edit Smart Stacks



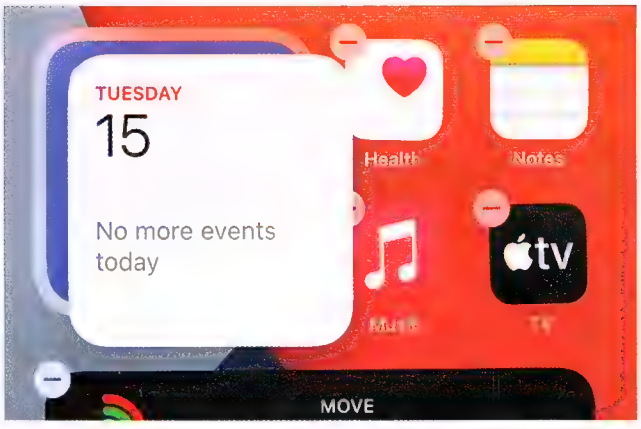
01 ADD A PRE-MADE SMART STACK

Tap and hold a blank area of the Home screen, tap the '+' button that appears in the top-left corner, then scroll down and tap Smart Stack. Swipe between the three available sizes and choose one, then tap Add Widget.



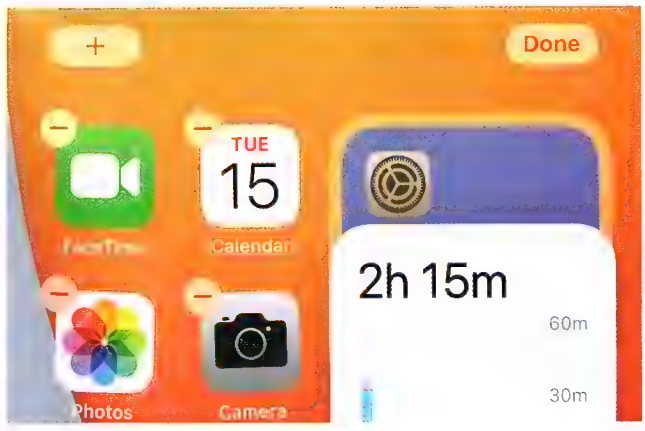
02 REORDER THE WIDGETS

If you want to edit a Smart Stack, tap and hold it until a contextual menu appears, then tap Edit Stack. You can use the handles on the right-hand side to rearrange widgets to your liking. When you are done, tap the cross.



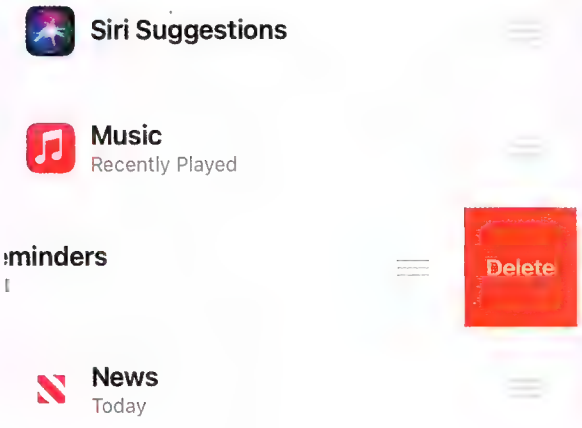
03 ADD A WIDGET TO A STACK

To add another widget to a Smart Stack, open the widgets menu from step 1, then drag and drop a new widget over an existing stack. All widgets must be the same size – you cannot combine large and small widgets, for example.



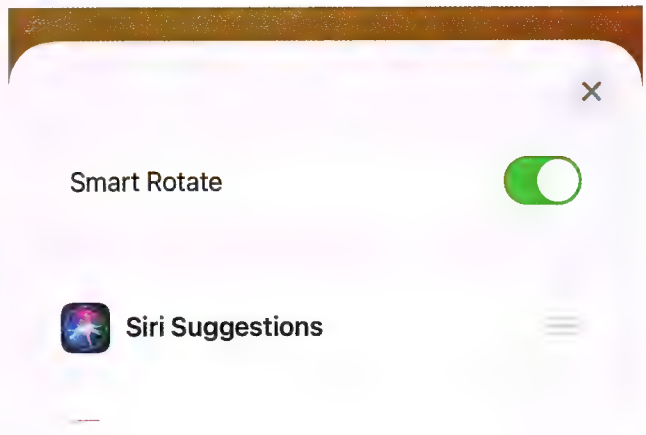
04 COMBINE EXISTING WIDGETS

You can also create a Smart Stack from two static widgets rather than from the pre-made Smart Stack widget – just enter jiggle mode, then drag one over the other in the same way as you would create an app folder.



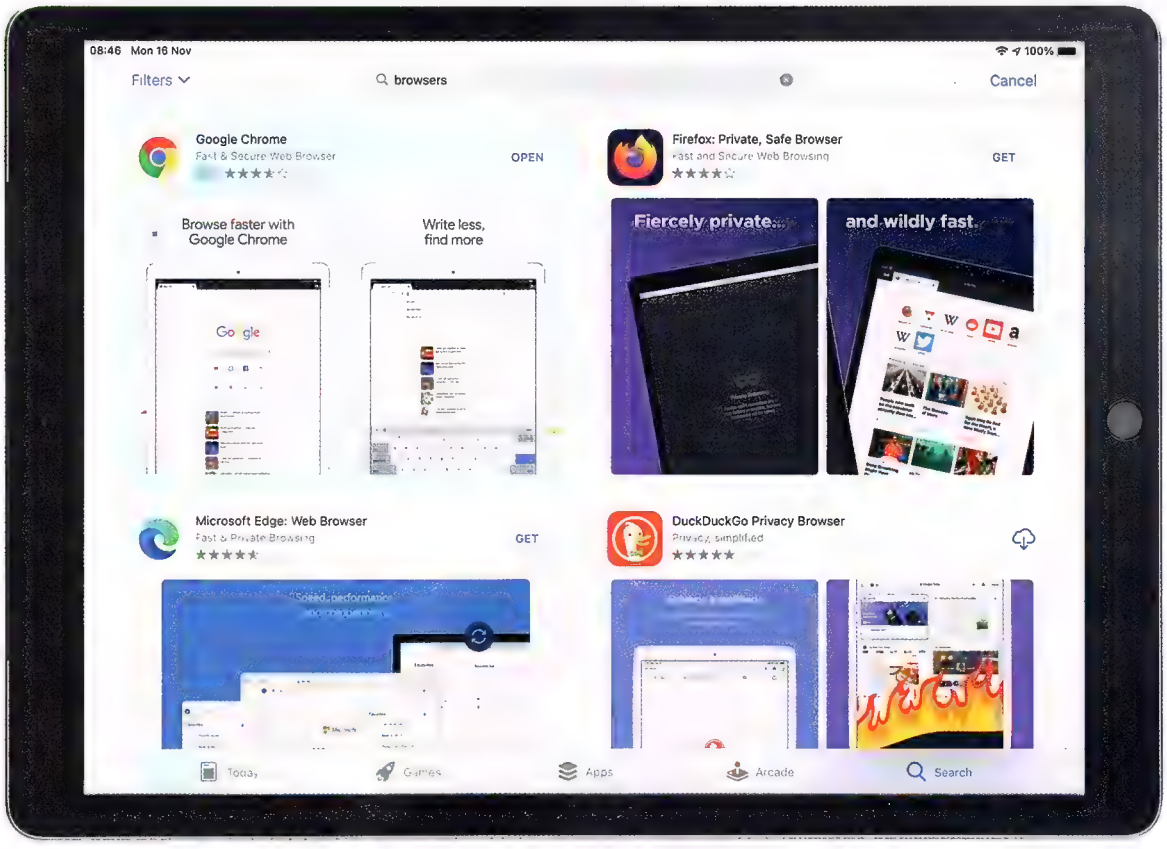
05 TRIM DOWN THE STACK

To remove a widget from a stack, tap and hold the widget and tap Edit Stack, then swipe from right to left. A short swipe brings up the Delete button, while a long swipe removes the widget without waiting for confirmation.



06 SMART ROTATE

At the top of the Edit Stack menu is a toggle for Smart Rotate. This orders widgets based on your usage habits. For instance, if you check the weather early in the day, it will appear at the top of the stack in the morning.



JARGON BUSTER
Default apps are the apps your iPhone or iPad is set up to use automatically: Mail for email, Safari for web browsing and so on.

GENIUS TIP!
Don't delete Mail if you want to keep using Siri Shortcuts such as "Send an email to...". For now, Siri doesn't recognise third-party mail apps.

iOS

Change the default apps

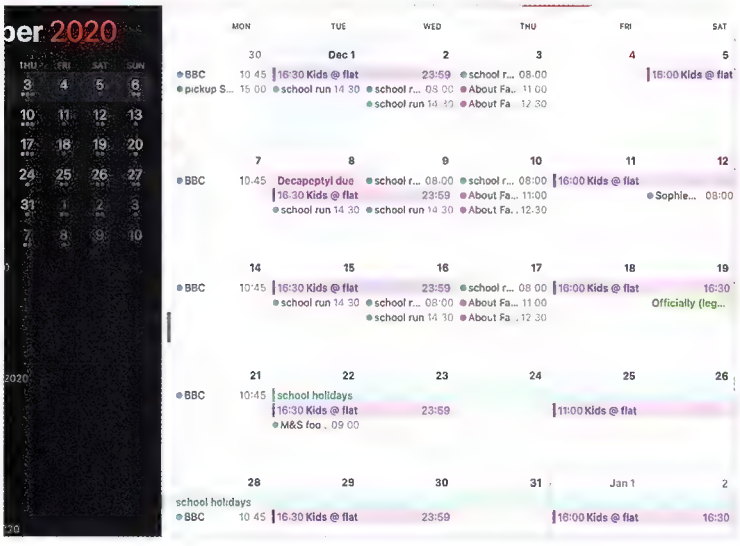
Want to swap Safari for Chrome? In iOS 14 and iPadOS 14, you can!

Apple's iOS and iPadOS apps are great, but they aren't always the best choice for everyone. That's why the App Store is filled with alternatives: Carrot Weather (and until Apple bought it, Dark Sky) as alternatives to Apple's own Weather; Fantastical instead of Calendar; Firefox instead of Safari, and so on. But while Apple was happy to let you install your chosen alternatives, it kept its own apps as the default – so if you clicked a link, it'd open in Safari; if you clicked an 'email us' button, it'd launch Mail. That's changed in iOS 14 and iPadOS 14.

IT WILL TAKE
5 minutes

YOU WILL LEARN
How to change the default apps on iPhone and iPad

YOU'LL NEED
iOS/iPadOS 14



For the time being, you can't change the default calendar app to use a third-party option such as Fantastical.

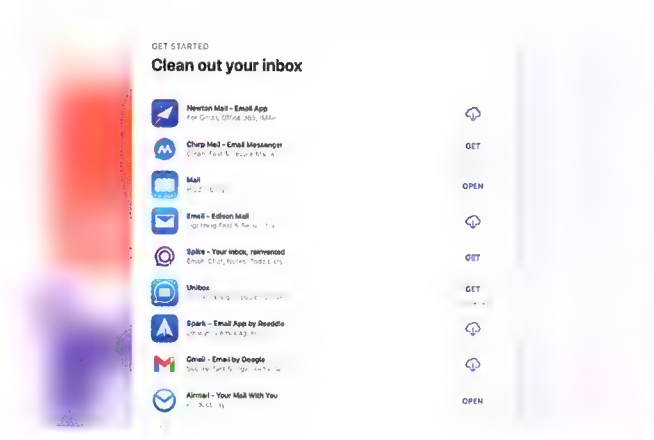
Simple, not Siri

It's only changed a little bit, though. For now, you can only change the defaults for two kinds of app: your web browser and your email app. In the longer term, we'd expect to see the ability to swap out the defaults for other things, so for example it'd be good to swap Calendar with Fantastical, Reminders with your favourite to-do app and so on.

As you can see, swapping the default mail and browser apps is simple. Unfortunately, getting them to stay swapped right now is a little trickier. There's a glitch that means the apps often revert to the system defaults after a software update, and we've found that Siri flatly refuses to respect our email choices: when we ask her to send an email, she always wants to do it with the default iPad Mail app.

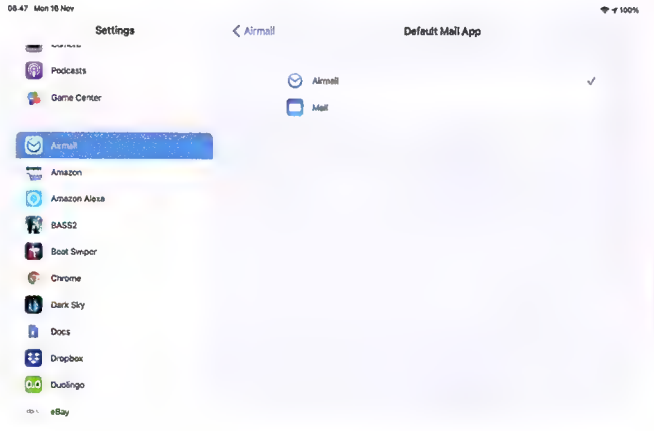
CARRIE MARSHALL

HOW TO Change the default apps



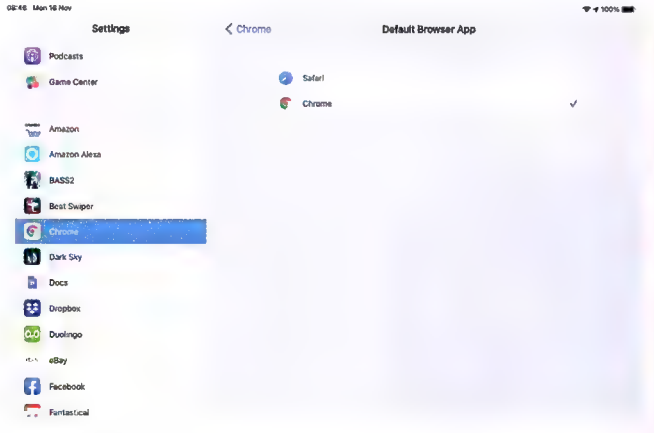
01 FIND THE ALTERNATIVE

The App Store is packed with alternatives to Apple's default email and web browsing apps, so the first step is to choose the one you want. The App Store provides some good round-ups of apps so that's a good place to start.



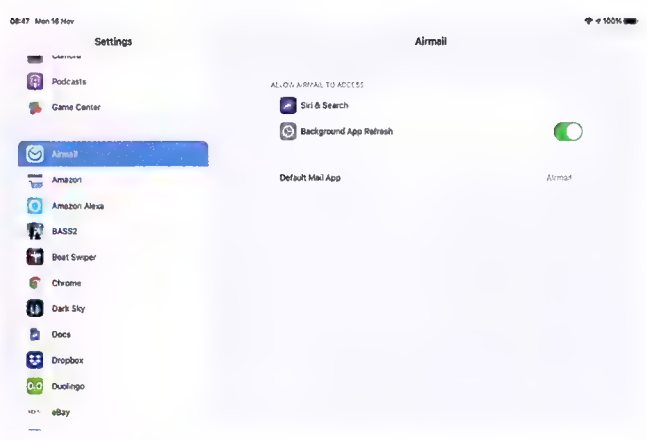
03 CHANGE THE DEFAULT

In the app's Settings page, you should now see an option that says Default Mail App. If you haven't already changed it, it'll be set to Mail. Tap on this and you'll see a list of installed email apps. Tap the one you want to use.



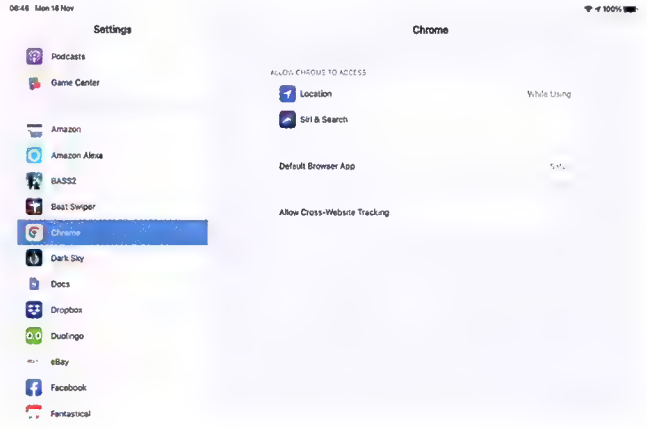
05 CHANGE THE BROWSER DEFAULT

Again it's a case of going into your iPhone or iPad's Settings app and scrolling down until you see the name of your preferred browser. Tap on it and then tap on Default Browser App, which will currently say Safari.



02 CHANGE YOUR EMAIL APP

Once you've set up the email app and connected it to your email account(s), the next step is to go into the Settings app on your iPhone or iPad. Scroll down until you see the name of the new email app and tap on it.



04 SWAP YOUR WEB BROWSER

The process for your web browser is almost identical. Once again, you'll need to find and install your preferred web browsing app before you can change the defaults. In this example, we're going to use Google Chrome.

06 DON'T ASK SIRI TO EMAIL

Once you've changed the defaults, your iPhone or iPad should use your preferred app for everything. We say 'should' because there are still bugs: Siri and some shortcuts rely on Mail and don't want to talk to third-party apps.

Partitioning disks from the command line

Formatting and partitioning hard disk isn't the exclusive domain of graphical tools. Shashank Sharma reveals the utilities that can make space for Linux.

Despite the constant push for user-friendly and intuitive graphical applications over the past decade, command-line utilities remain popular for performing a vast number of tasks. Whether its cloning your disk, transferring files across the network, communicating with peers, or even accessing social media, you can do it all from the relative comfort of the Linux shell.

Partitioning the hard disk, however, is one area where many users still prefer the point-and-click convenience of graphical tools. This is mostly because of lack of familiarity and not because the tools are lacking in abilities. In the late 90s and early 2000s, Linux users had to contend with only command-line tools to perform partitioning. In fact, *fdisk* is still the default, and it's the only partitioning tool on some Linux distributions such as Slackware.

In this tutorial we'll discuss all the functions you might have to perform to carve space on the disk for your distribution, such as creating and deleting a partition, and more. If you're interested in learning whether partitions can be resized from the command-line too, refer to the Resizing Partitions box (*below left*).

The *fdisk* utility, along with many other tools, are part of the **linux-utils** package that's part of the default installation on Linux distributions.

Not an expletive

The powerful *fdisk* utility can be used to create and delete partitions on the disk, so you must use it with extreme caution or risk losing all data on your disk. You can run the `sudo fdisk -l <dev>` command to get the utility to list all the partitions on the specified device: [Image A]

If no device name is specified to the `sudo fdisk -l` command, the utility will provide details for all the partitions listed in the **/etc/partitions** file.

As you can see, *fdisk* correctly identifies not only the size of each of the partitions, but also its type, whether it's ext3, NTFS, swap and so on.

Command mode

Functions such as creating, deleting or changing the type of partition must be performed from the Command mode, which can be accessed by running the `sudo fdisk /dev/sda` command. Replace `/dev/sda` with the device you wish to work with on your machine.

The *fdisk* Command mode utilises single letter commands to specify the functions you wish to perform. Press 'm' for a list of all available commands. The older versions of the utility produced a running list of available commands, but now the output is split under different headings such as Dos, Generic and Misc, along with a brief description of the action each command performs. For instance, press 'p' in the command-mode to print the current partition table. This

Resizing partitions

While *fdisk* can't be used to resize existing partitions, you can modify partitions with the *parted* utility. The process isn't without risk however, so make sure you have a complete backup of all your data, and more importantly, very good reason to mess about with non-empty partitions. A read-through of the manual can't hurt, either.

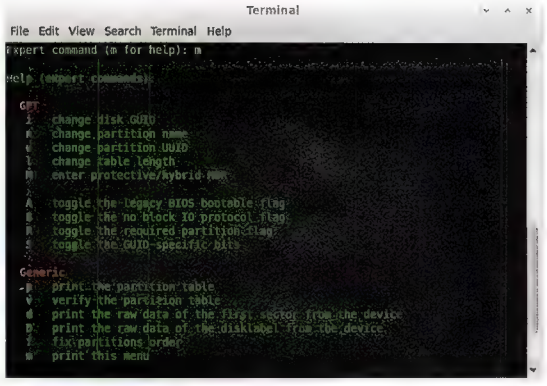
To begin, you'll have to start *parted* much the same way as *fdisk*. Before anything else, change the default unit for describing the start, end and size of partitions to MiB by pressing 'u' and then typing `MiB` when prompted to specify the unit. Depending on your disk and partition size, you can also opt for GiB as the unit.

Before you can expand, or shrink a partition, it must first be removed from the partition table. Type `rm` and then select the partition you wish to modify. Make sure to note the start position for the partition you wish to edit. This must remain unchanged. The partition you wish to expand must have free space at the end, or to its right, in layman's terms.

With that sorted, type `mkpart` and follow the on-screen instructions and specify the name, filesystem and starting location for the partition. This must be same as before. When you're asked to specify the end location, specify a number that's greater than the original end location. Exit *parted* by typing `quit` . All you need to do now is run the `resize2fs` command.

Ncdu provides the same functionality as du, but features a text-based interface. You'll find it in the software repositories of most distros.

```
linuxlala@playground:~$ sudo fdisk -l /dev/sda
[sudo] password for linuxlala:
Disk /dev/sda: 465.78 GiB, 500107862016 bytes, 976773168 sectors
Disk model: WDC WD5000LPVX-0
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 4096 bytes
I/O size (minimum/optimal): 4096 bytes / 4096 bytes
Disklabel type: dos
Disk identifier: 0xf39465b4

Device     Boot     Start       End   Sectors   Size Id Type
/dev/sda1  *         2048   2099199   2097152     1G  b W95 FAT32
/dev/sda2         2099200  10487807   8388608     4G 82 Linux swap / Solaris
/dev/sda3        10489854 739037278 728547425 347.4G  5 Extended
/dev/sda5        10489856  92409777  81919922  39.1G 83 Linux
/dev/sda6        92411904 483036903 390625000 186.3G  7 HPFS/NTFS/exFAT
/dev/sda7       483039232 739037278 255998047 122.1G 83 Linux
```


Terminal
File Edit View Search Terminal Help
Expert command (m for help): m
Help (expert commands):
GPT
c change disk GUID
n change partition name
u change partition UUID
l change table length
M enter protective/hybrid MBR
A toggle the legacy BIOS bootable flag
B toggle the no block IO protocol flag
R toggle the required partition flag
T toggle the GUID specific bits
Generic
p print the partition table
v verify the partition table
d print the raw data of the first sector from the device
D print the raw data of the disklabel from the device
f fix partitions order
m print this menu

You can only perform operations from the command mode on an inactive hard disk.

will generate the same output as produced by the `sudo fdisk -l devsda` command

If your disk doesn't have any partitions, such as when working with a new disk or practising on a virtual hard disk, you must begin by creating a partition table. From the command mode, press 'o' to create a MBR or 'g' if you wish to create a GPT partition table.

The partition table is used to describe the partitions on a hard disk. MBR partition table was the standard and is still popularly used for disks up to 2TB in size. Larger disks, however, require a GPT partition table. Although older versions of *fdisk* only supported creating a MBR partition table, *fdisk* added support for GPT partition table many years ago.

The next step is to create a new partition on this disk, which is done by pressing 'n'. If you've opted for an MBR partition table, you'll be asked to choose whether you wish to create a Primary or Extended partition. For each partition you create, you must specify the start and end sectors on the disk, which are used to determine the size of the partition:

```
Command (m for help): n
Partition type
   p   primary (0 primary, 0
extended, 4 free)
   e   extended (container for
logical partitions)
Select (default p): p
Partition number (1-4, default 1):
First sector (2048-31457279,
default 2048):
Last sector, +/-sectors or
+/-size(K,M,G,T,P) (2048-
31457279, default 31457279):
+5G
Created a new partition 1 of type
'Linux' and of size 5 GiB
```

As far as possible, *fdisk* will provide a default choice for each question put to you. For instance, if you don't specify the last sector for a partition, the default is to use the entire space on the disk. Alternatively, you can specify the size in MB or GB manually. `+5G` as used in our example above creates a 5GB partition. You can similarly use M to define the size of partition in megabytes, or K for kilobyte.

To create different partitions, such as Swap or NTFS, you'll have to change the partition type after creating the new partition. You can do this by pressing 't', and then selecting the partition you wish to modify. For a list of all supported filesystem types, press 'L'.

The process to delete the partition is also similar. Press 'd' and then select the partition you wish to delete. You can quit the command mode by pressing 'q' and all the changes you made will be discarded. Changes to the partition table, whether creating a new partition, changing the partition type or deleting a partition are not written until you write the table to disk. When you type 'w', *fdisk* will write all changes to the disk, quit the command mode and return you back to the shell.

Expert mode

Apart from the regular commands that can be run from the command mode, there are more functions that you can perform by entering the Expert mode. This is done by pressing 'x'. You'll rarely have to work with any of the commands in the Expert mode. The only exception is the 'f' command to fix partitions order. This is necessary when you delete and then create new partitions, which affects the numbering of scheme for the different partitions.

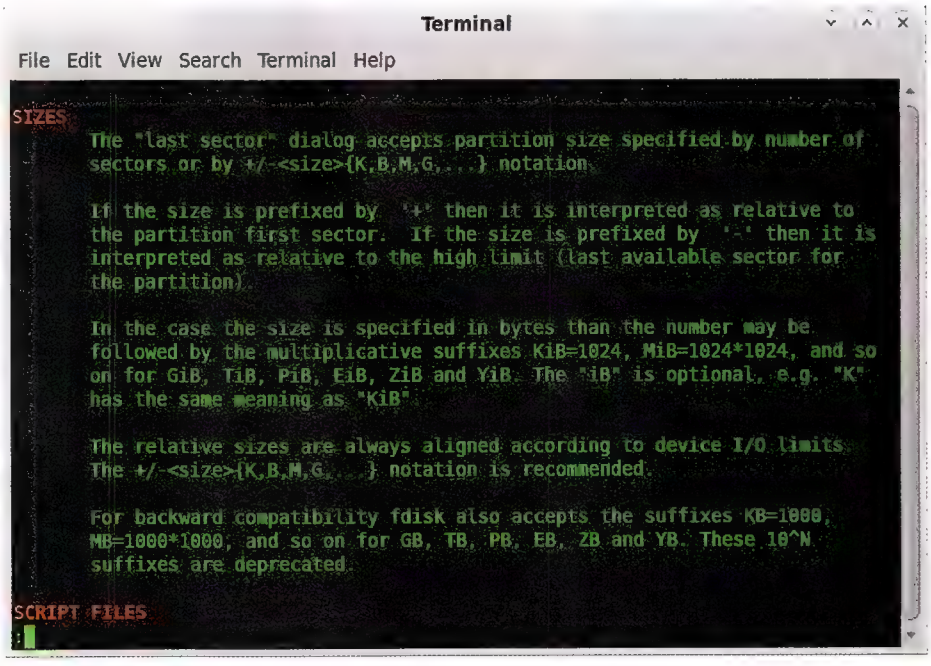
There's still more that you can do with *fdisk*, such as toggle the bootable flag for a partition.

The *fdisk* utility can only be used to create or delete, or manipulate partitions. Once a new partition is created, you still need to format it. The command to do so depends on the filesystem you wish to use, whether it's ext3, ext4, reiserfs and so on.

Finally, we'd like to suggest that if you've never used *fdisk* before, don't experiment on a disk with any crucial data. All data will be lost as soon as you make changes to the partition table and write them to disk. ■

"In this tutorial we'll discuss all the functions you might have to perform to carve space on the disk for your distribution, such as creating and deleting a partition, and more."

Refer to the man page for more details on how and when to use the other fdisk commands.


Terminal
File Edit View Search Terminal Help
SIZES
The "last sector" dialog accepts partition size specified by number of sectors or by +/-<size>{K,B,M,G,...} notation.
If the size is prefixed by '+' then it is interpreted as relative to the partition first sector. If the size is prefixed by '-' then it is interpreted as relative to the high limit (last available sector for the partition).
In the case the size is specified in bytes than the number may be followed by the multiplicative suffixes KiB=1024, MiB=1024*1024, and so on for GiB, TiB, PiB, EiB, ZiB and YiB. The "iB" is optional, e.g. "K" has the same meaning as "KiB".
The relative sizes are always aligned according to device I/O limits. The +/-<size>{K,B,M,G,...} notation is recommended.
For backward compatibility fdisk also accepts the suffixes KB=1000, MB=1000*1000, and so on for GB, TB, PB, EB, ZB and YB. These 10^N suffixes are deprecated.
SCRIPT FILES

Build a mobile Wi-Fi media server for under $80

Android smartphones offer excellent functionality for little cash. Darren Yates shows you how to turn one into a portable Wi-Fi media server with 128GB of storage for under $80.

Over the last five years, we've seen Android smartphones not only crash-dive in price, but also explode with processing speed and functionalities. Even in the pre-paid budget end of the market, quad-core CPUs are abundant. This month, we combine one of these phones with a 128GB microSD card to create a pocket media server for as little as $80.

Pre-paid budget phones

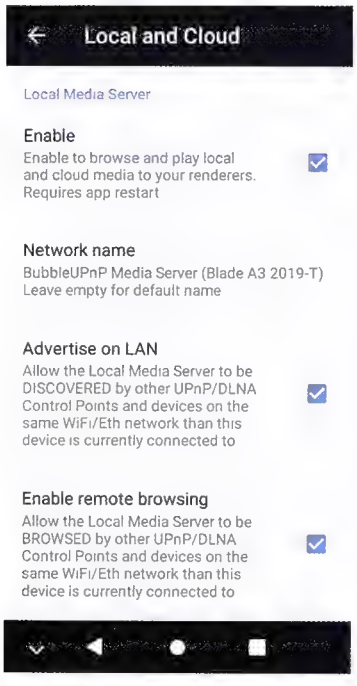
While flagship phones grab plenty of eyeballs, it's the budget market that grabs the wallets. These low-cost models rarely spark excitement, but when you consider you get a fully-functional computer for as little as $39, I find them too hard to pass up. Recently, Telstra's Essential Smart 2 (ES2, a re-badged ZTE Blade A3-2019) sold in Coles supermarkets for $39 and I couldn't resist. It's locked to Telstra at this price and only includes 1GB of RAM, a quad-core Cortex-A53 SoC and Android Go 9.0 operating system, but really, who cares? Ditch the SIM card and I still reckon you get more for your money here than with a Raspberry Pi. Still, if you have an old phone holding up a load-bearing wall or something, even better – as long as it has at least Android 5.0, it should work a treat (albeit with possibly lower storage limits).

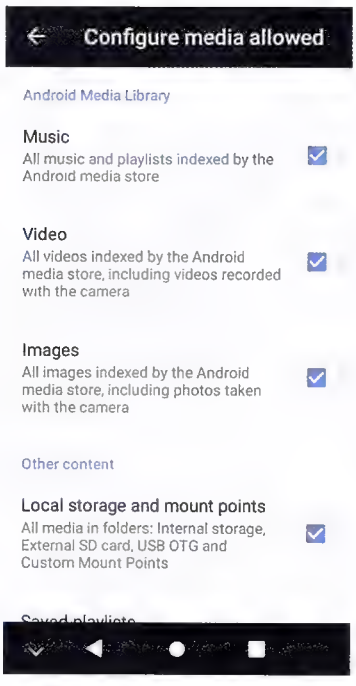
We picked up the Telstra ES2 phone for $39 from a local Coles supermarket.

128GB? Hold me back!

Yep, okay, 128GB isn't going to set the world alight for capacity, but then again, most media servers don't offer battery power or slot into your pocket, either. If you're worried a phone isn't fast enough to deliver streaming video, think again. Synology's DSX18-series of value NAS boxes use a 1.4GHz quad-core ARM Cortex-A53 chip, the same CPU architecture and clock speed inside the Telstra ES2 phone. A one-bay DS118 will cost you about $250 without Wi-Fi and storage – admittedly, it'll give you far more storage than a microSDXC card, but where's the fun in that?

The point is never dismiss a budget phone as just a toy – they do far more than you might think.


Local and Cloud
Local Media Server
Enable
Enable to browse and play local and cloud media to your renderers. Requires app restart
Network name
BubbleUPnP Media Server (Blade A3 2019-T)
Leave empty for default name
Advertise on LAN
Allow the Local Media Server to be DISCOVERED by other UPnP/DLNA Control Points and devices on the same WiFi/Eth network than this device is currently connected to
Enable remote browsing
Allow the Local Media Server to be BROWSED by other UPnP/DLNA Control Points and devices on the same WiFi/Eth network than this device is currently connected to


Configure media allowed
Android Media Library
Music
All music and playlists indexed by the Android media store
Video
All videos indexed by the Android media store, including videos recorded with the camera
Images
All images indexed by the Android media store, including photos taken with the camera
Other content
Local storage and mount points
All media in folders: Internal storage, External SD card, USB OTG and Custom Mount Points

Far left: Make sure to check the correct settings in BubbleUPnP on your server phone. **Left:** Also check your media folders so other local network devices can find them.

What you need

We'll use the Telstra ES2 for its support of 256GB of microSD storage, but any of today's Android phones should work. The ES2 only has 16GB on-board, so to get our 128GB, you'll find a 128GB Sandisk microSDXC card for under $40 at quite a few retailers.

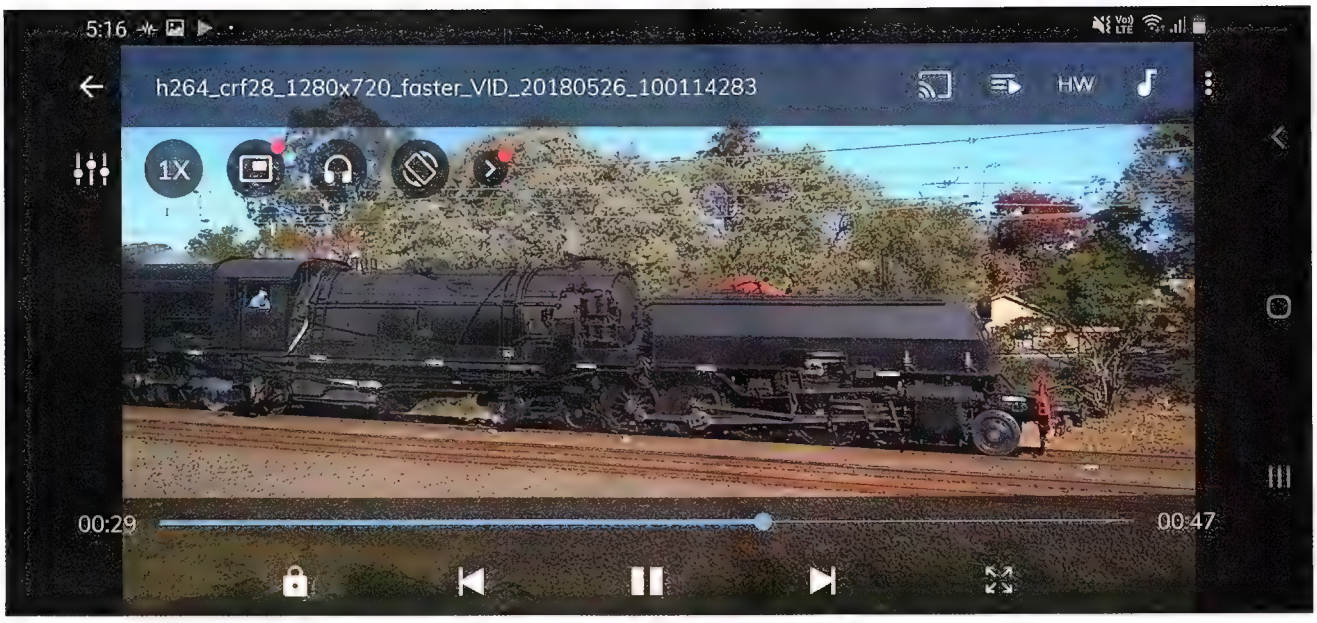
As for software, the only Android apps you need are free from Google Play – the first is BubbleUPnP. This app includes a built-in UPnP media server that stream files from internal and external storage.

To play these files on another device, you'll need either a combo of BubbleUPnP and MX Player for Android devices, or the ever-reliable VLC for Windows PCs. Here's how it all goes together.

Setting up – server

Download BubbleUPnP from Google Play onto the server device and launch it. Next, tap on the 'More' option on the bottom-left of screen. Now tap the gearwheel to load settings. Scroll down to 'Local and Cloud' and tap it.

Now make sure 'Enabled', 'Advertise on LAN' and 'Enable remote browsing' options are all checked. On checking the latter, you'll get a notification message, tap 'OK'. After this, 'Configure media allowed for remote browsing' will appear on the previous screen. Tap it. On the new screen, check the box next to 'Local storage and mount points'



and make sure the audio, video, image and SD card options are also set. After this, back out to the main screen and you're done.

Setting up – client

If you're on a PC, just download, install and fire up VLC (**videolan.org**). Upon launching the app, click the 'Universal Plug and Play' entry on the left-side menu under 'Local Network', give it a few seconds, then double-click on the 'BubbleUPnP Media Server' entry when it appears. Double-click 'videos' or wherever you put your video files, double-click on one and it should begin to play on your PC (it won't download the file first, it should just start streaming).

Android client users need to first install MX Player from Google Play (don't forget the MX Player Codec add-on also), then install BubbleUPnP. Again, with BubbleUPnP on the server device up and running, launch BubbleUPnP on your client/playback device. Tap the Library icon on the bottom-right, then tap the yellow folder icon just above on the new screen. Select the BubbleUPnP Media Server entry and you'll now get the folder list of that server device on your client device screen. Double-tap on a file, give it a few seconds and you should see playback get underway on your client device.

Provided your server phone has a quad-core CPU and 802.11g Wi-Fi or better, you shouldn't have any trouble with it serving multiple clients with different files concurrently (our quick test had the Telstra ES2 serving two different 720p HD streams concurrently to a PC and another phone over a home Wi-Fi network). If you have a linked Google Chromecast dongle, you should be able to cast the video from MX Player to your big-screen TV as well.

Use VLC on your PC to find and choose files on your BubbleUPnP media server phone.

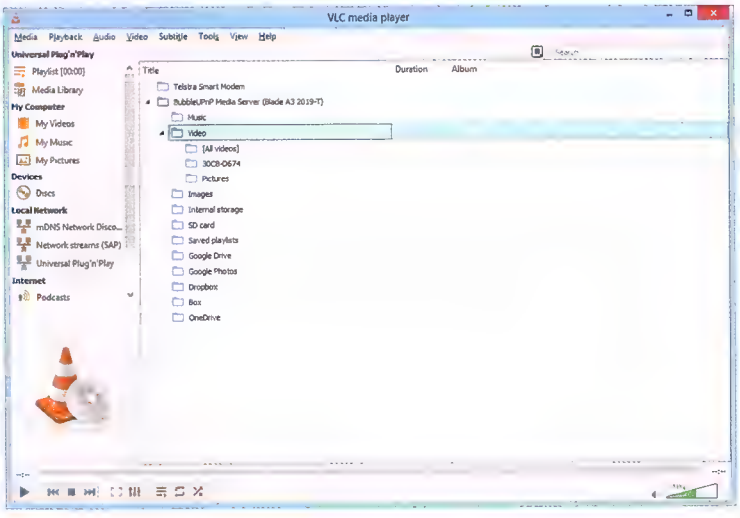
Ideal video file bitrates

A 128GB microSD file doesn't sound like much, but if you're encoding your own videos, you should be able to encode 720p HD videos at around 1.5GB per hour and still get very good quality (that's around 3Mbps for video and 256Kbps for audio). At that rate, you should get roughly 40 or so two-hour movies onto a 128GB card, or 80-odd on a 256GB card. Again, it's not huge, but if you need a small household server, you won't get much smaller than this. You can encode 1080p videos at this rate, however they'll likely look just a little the worse for wear.

Try it out

Budget Android phones have had the horsepower for this task for some time, but what's more recent is the boost in the microSD card storage they can handle. With even the Telstra ES2 handling up to 256GB, that's plenty of movies, music and more movies.

We can't guarantee this setup will work with every phone, but we've tested it on the Telstra ES2 and it worked nicely. Most compact file servers run a Linux base and often have no more processing power than budget phones, so if you need a media server that's as easy to pack as slotting into your pocket, give this one a go. Better still, if you already have the gear, it won't cost you a cent.



BubbleUPnP on a client phone can stream videos to MX Player on that device.

Make security cameras With motionEyeOS

Ian Evenden has a practical Pi feature this month.

Give a person a camera, and they'll find a way to point it at other people. Most of the single-board computers that are popular at the moment have camera attachments, or can use a webcam through a USB port. MotionEyeOS is an operating system that does nothing but operate cameras, and it can be installed on a great many of these boards – we're using a Raspberry Pi Zero W, but Banana Pi, NanoPi, ODROID, and Pine boards are all compatible.

MotionEyeOS is a lightweight way to run motionEye, the web interface that gathers together the feeds from connected cameras and displays them, running motion-detection routines and triggering recordings or stills when motion is detected. It can take feeds from connected cameras or network cameras, and multiple boards can work together as individual cameras or hubs.

The whole thing is the work of Calin Crisan, a developer who has also taken the time to write a wiki detailing the installation and usage of the OS on its Github page. There's a lot more going on than we can cover in this simple tutorial, so if you want to make a complex surveillance system relatively cheaply, this might be a good way of going about it.

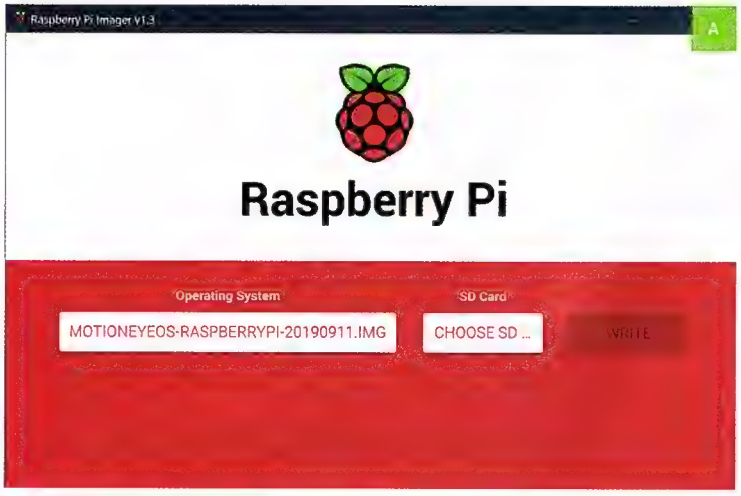
YOU'LL NEED
A single-board computer
Compatible camera(s). A microSD card.
MotionEyeOS

Set up your hardware

We're using a 16GB microSD for this, but any capacity will do. Download the motionEyeOS from **https://github.com/ccrisan/motioneyeos/wiki**, and the Raspberry Pi Imager from **https://www.raspberrypi.org/software/**. Install the app on a Windows PC (or a Mac, or Ubuntu) and use it to install the OS from its ISO to your SD card [Image A]. To get the Pi to connect to your network, you have a choice: You can connect a USB-to-Ethernet adapter via the microUSB port and connect it to a wired network, or you can preload it with your Wi-Fi details. When it's finished, pop the card out, then put it back in again – in Windows, you'll probably get an error saying your card needs to be formatted, but don't press "OK" – the FAT32 partition will mount and be readable. Open this from This PC, and use something like Notepad++ (Windows's built-in Notepad doesn't format the lines correctly) to create a new text file in the root directory with the name "wpa_supplicant.conf" – remove any .txt extensions. This information enables the Pi Zero to connect to your Wi-Fi. The content of the plain text file should be this:

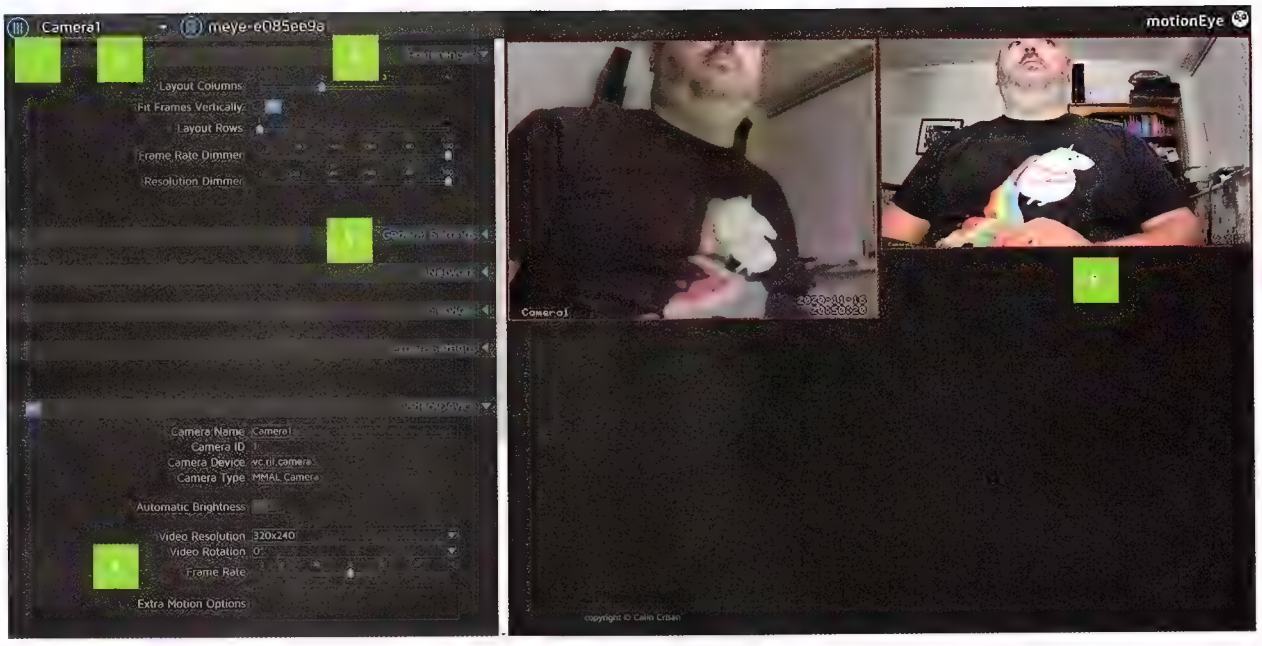
```
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
country=[your country in two letters,eg: US]
update_config=1

network={
ssid="Network"
psk="Password"
}
```

In Notepad++, set the EOL conversion to UNIX LineFeeds ("Edit > EOL Conversion > Unix LF"). This is important, because without a properly formatted file the Pi won't read it, won't be able to find a network, will put up unhelpful error messages involving the word "panic," and will restart in a loop. When you've saved the file, pop the microSD card into the Pi Zero, clip it into its case (we find it easier to handle the tiny board when it's in a case), and attach the HDMI and USB adapters, plus the camera on its flex cable. Be careful when plugging the camera in, as the camera for the Pi Zero comes with a thinner and more easily torn ribbon cable, and its camera port is quite tight.



Other OSes

If you don't want to turn your board into a dedicated camera system, it's possible to install motionEye, without the OS, on other operating systems. Many flavours of Linux can take it, including the Raspbian (now called Raspberry Pi OS) distribution that powers the Raspberry Pi boards (make sure you enable the camera module in Raspi Config if you're going to use one). It has all the same features as the OS version, including the ability to carry the feeds from network cameras, something we didn't explore in the main tutorial. Running on a more powerful PC, motionEye could detect motion from a number of network cameras scattered across a property but within Wi-Fi range of a router or hotspot, with the web interface always available in the user's browser. You can even install it in Docker.



The interface

1. THREE LINES
Click here to get to all the options for the operating system. Without the menu open, the camera feeds completely fill the interface.

2. CAMERA MENU
Drop this menu down to find options to add a camera, select an existing one, or use the trashcan button to delete one of the cameras.

3. ID NUMBER
This is the ID of your motionEyeOS installation. Look out for it on the local network, as it will designate your Samba share.

4. CAMERA SETTINGS
The most important menu. Change the camera's resolution and frame rate here, and flip the video over if the camera's been installed upside down.

5. OTHER SETTINGS
There are so many, we could be here all week. The key to a successful installation is correct configuration with reference to the online help files.

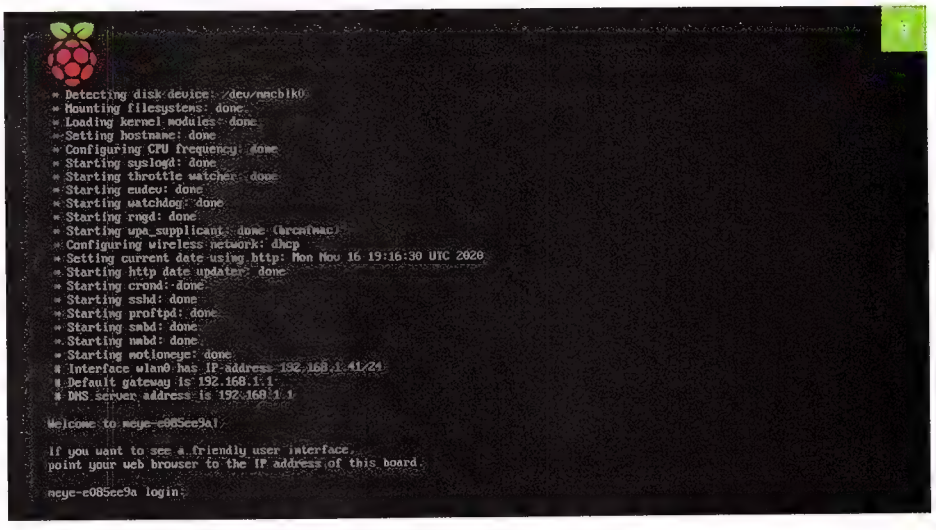
6. CAMERA FEEDS
Camera names and dates are superimposed over the feeds. You can add extra buttons too, in order to execute custom commands.

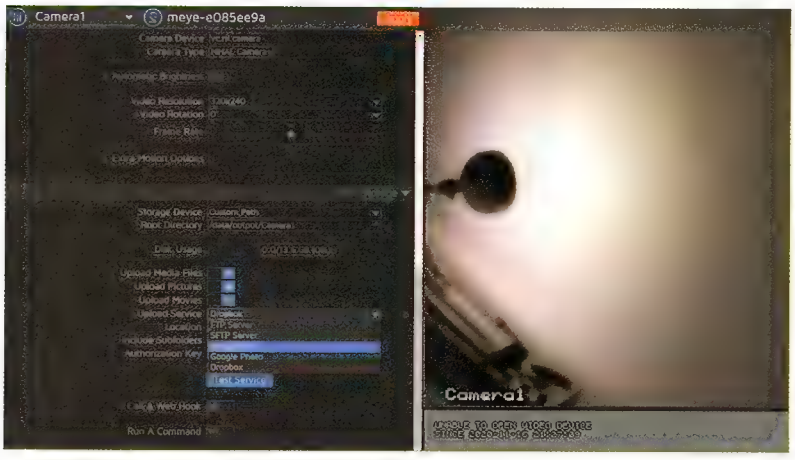
First boot

You'll know that it's working once a green light flashes on the board, and a red raspberry graphic appears on the screen, along with some text. You won't need the screen for most of this, but it's handy to have at the beginning. It takes a while to boot the first time, while it sets up its hardware, but eventually you'll be faced with a login prompt and a welcome message telling you to go to the board's IP address for a more friendly interface [Image B]. The IP address is listed above this: Type the address itself – anything after it (such as /24) generally gets you an error message.

Web interface

Go to the web interface on another computer, cellphone, or tablet. The web interface is much nicer than the text-based output from the Pi itself. If you're asked to login, the default admin account is "admin" with no password (there are two users, admin and user, with the latter meant for everyday use). If you're going to deploy motionEyeOS as a camera system, you'll want to add some passwords, but for now it will do. At the left-hand side of the interface is a three-line menu button, and the first place you should go is "Software Update" under General Settings – if there's an updated version of the OS available, it'll download and install without much input from you. You can shut down and restart the board from the same place. Your initial camera will be in a window near the center of the interface, and by selecting the camera in the settings menu you can tweak settings, such as frame rate or resolution.


* Detecting disk device: /dev/mmcblk0
* Mounting filesystems: done.
* Loading kernel modules: done.
* Setting hostname: done.
* Configuring CPU frequency: done.
* Starting syslogd: done.
* Starting throttle watcher: done.
* Starting eudev: done.
* Starting watchdog: done.
* Starting rngd: done.
* Starting wpa_supplicant: done (brcmfmac)
* Configuring wireless network: dhcp
* Setting current date using http: Mon Nov 16 19:16:30 UTC 2020
* Starting http date update: done.
* Starting crond: done.
* Starting sshd: done.
* Starting proftpd: done.
* Starting smbd: done.
* Starting nmbd: done.
* Starting motioneye: done.
* Interface wlan0 has IP address 192.168.1.41/24
* Default gateway is 192.168.1.1
* DNS server address is 192.168.1.1
Welcome to meye-e085ee9a!
If you want to see a friendly user interface,
point your web browser to the IP address of this board.
meye-e085ee9a login:



The cloud

Of course, you can upload stills and videos to the cloud. Alongside options to save them to the FTP and Samba shares on the board's microSD card, there are entries on the dropdown menu under "File Storage for Google Drive, Google Photos, and Dropbox." This opens it up for use with IFTT, perhaps triggering a phone alert when a new image is uploaded to the Google Drive folder, or extending the built-in email system. This is also a useful security measure, as a burglar who discovers your system may try to swipe the microSD cards to cover their tracks – they can't do the same to Google Drive.

Add a new camera

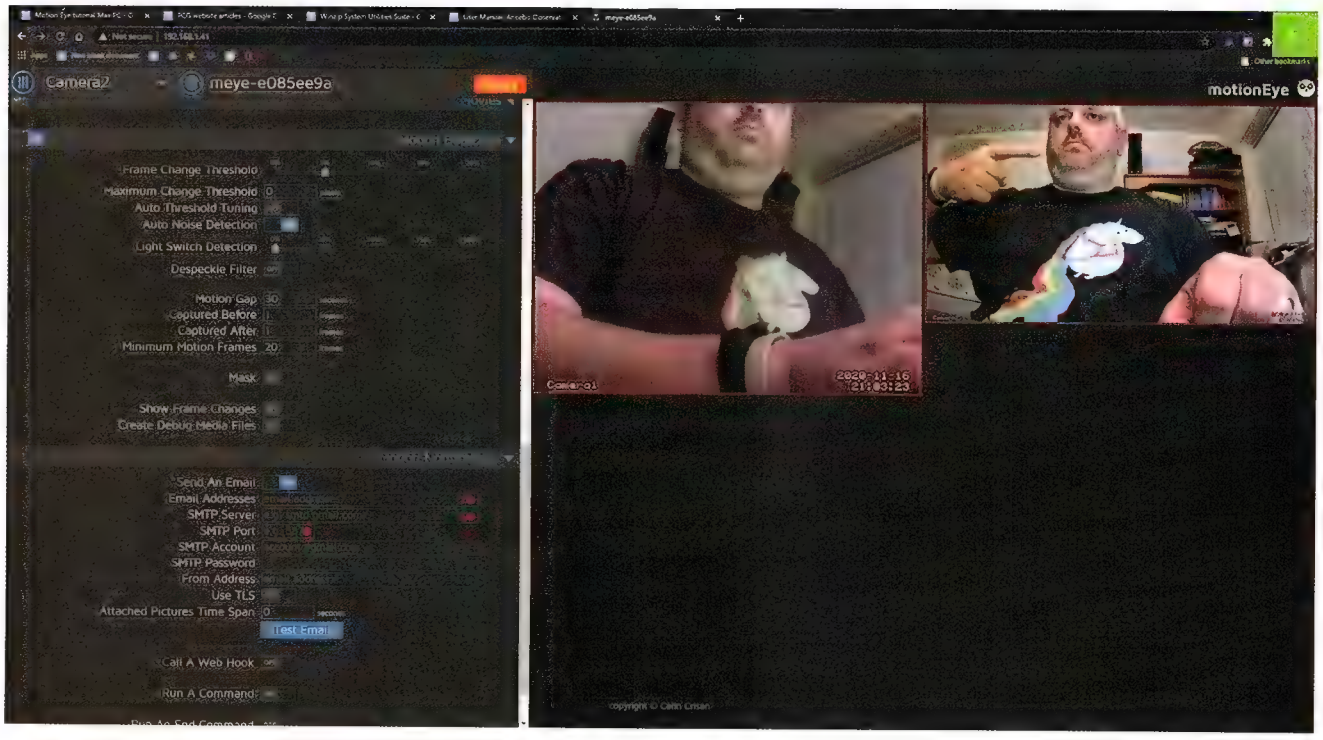
You're not limited to one camera in motionEyeOS. Although there's only one dedicated camera port on the Pi Zero board, it does have a USB socket through which we can add another. Pulling the USB webcam off the back of our gaming PC, we plugged it in with a USB OTG adapter, and hit "Add Camera" in the camera dropdown menu at the top right. The USB webcam is a different type to the one on the camera port, but with a bit of trial and error we found a setting that worked. The more cameras you add, the greater the strain on the board, and our Pi Zero was easily overwhelmed.

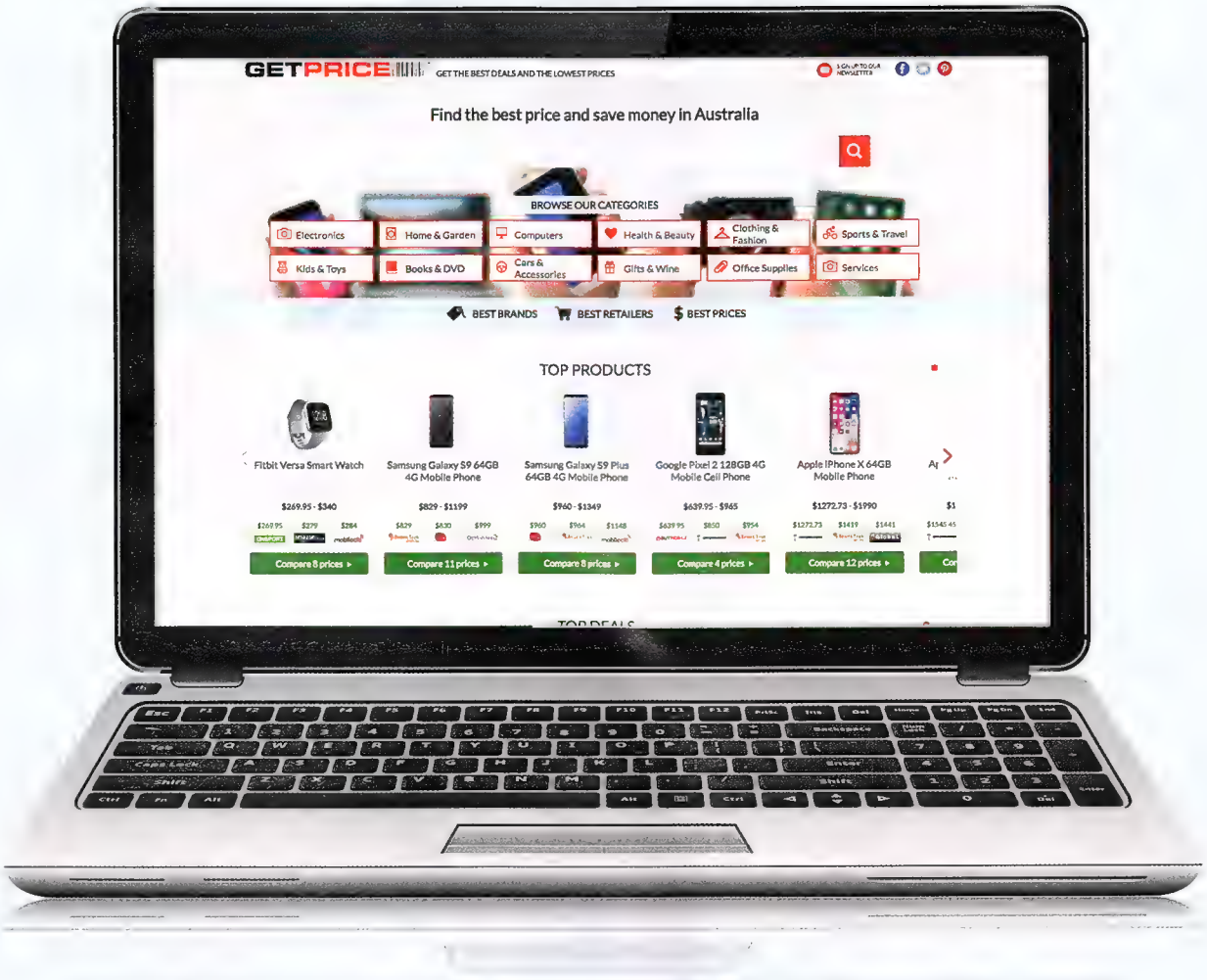
Motion detection and recording

"Motion" is aptly named for its motion-detecting abilities. You access these from further down the menu, and can set how much of the frame has to change to qualify as motion – perhaps to stop a gentle breeze from triggering an alert – as well as what happens when it's detected. Possibly the most useful is to receive an email [Image C], and the OS runs both FTP and Samba servers for you to access the still images and videos it can record of motion events. This uses local storage on the Pi's microSD, and although the OS itself is tiny, video files can take up much more space, so consider your needs if setting up a surveillance network, and buy cards of suitable speed and capacity.

Limitations

In hindsight, the Pi Zero wasn't the right board for this. It worked, but with frame rates in the region of one every five seconds, it's not the ideal way of setting up a multi-camera system or detecting motion. Even reducing the cameras to their lowest resolution and enabling some overclocking features on the Pi didn't help. However, we can imagine that outfitting a Zero with one camera (a model with both day and night-vision capabilities), and having it feed to a Pi 4B configured as a hub for several Zeros, and streaming to a second Pi with a monitor, might work very nicely.





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The Amstrad's strikingly colourful buttons add to the visual effect Alan Sugar cynically dubbed "a mug's eyeful."

MACHINE OF THE MONTH

Amstrad CPC (1984)

John Knight goes way back to this attractive and popular computer.

The Amstrad CPC was a darling of Europe and Australia, and a key player in the 8-bit gaming world. A product of Lord Alan Sugar, this machine was designed to take the fight to the mighty Commodore 64 and British rivals such as the BBC Micro and ZX Spectrum.

With a production run lasting into the mid-'90s, there is an enormous amount of software for any retro gamers seeking undiscovered gems. However, the machine was never launched in the US, meaning emulation is the only real option for Americans wanting some Amstrad action.

So, come along as we explore the history of this overlooked machine, and provide instructions for emulating the Amstrad CPC in the easiest ways possible.

A brief history

When it came to the original CPC464, Sugar made some interesting design choices. Where other micros relied on separate televisions and tape decks, Amstrad's tactic was to simplify the system by integrating the cassette deck. And fighting the established wisdom of television-based micros, Amstrad gambled on people wanting to use a stand-alone monitor instead of sharing the family TV.

Microsoft's BASIC – the language of nearly all other micros – was seen as too expensive, so Sugar cut costs by commissioning his own BASIC interpreter.

While rivals kept gaming at a distance from their company image, Amstrad actively embraced gaming, starting its own Amsoft label to bundle a selection of games with the machine.

SPECIFICATIONS **CPU:** Zilog Z80A @ 4MHz **RAM:** 64KB **Graphics:** 16 colours @ 160x200, 4 colors @ 320x200, 2 colours @ 640x200 **Sound:** General Instrument AY-3-8910 3 PSG **Storage:** Cassette and 3-inch floppy **OS:** AMSDOS and Locomotive BASIC **Released:** April 1984 **Production:** 1984–1992 **Worldwide sales:** 3 million

The gaming experience

Sporting 64K of RAM and a Z80A CPU, the 464 is perhaps somewhere between a Commodore 64 and ZX Spectrum. Its General Instrument AY-3-8910 sound chip was something of an 8-bit micro standard, and although its sound was a lot more "bleep-bloop" than the immortal SID chip in its Commodore rival, it did at least have stereo. On the other hand, its Zilog CPU was faster than the Commodore, and the Amstrad didn't suffer from the Spectrum's ghastly colour clash.

Get Dexter (1986) is a classic French title that used Amstrad hardware properly.

Love it or hate it, the CPC's colour palette is especially bright and was one of the standout features of the system, making Commodore 64 games look muted in comparison.

Unfortunately, a shared CPU meant a lot of Amstrad games were simply ported from the Spectrum, often badly. A good release was similar to a Commodore 64 game, with brighter colours and the advantage of a faster CPU.

Classic gaming

Horizontal scrolling was the Achilles heel of Amstrads, where platformers tended to be flick-screen rather than use proper four-way scrolling. Nevertheless, there is plenty of classic gaming to be had. The '80s produced classics such as *Who Dares Wins 2*, *Tornado Low Level*, *Head Over Heels*, *Spindizzy*, and a solid port of *Arkanoid*. When the '90s arrived, coders were really getting to grips with the system, with more advanced games such as *Prehistorik II*, and a very respectable version of *Prince of Persia*, the only official port on an 8-bit platform.

How did it play out?

Quite well, actually. Although overshadowed by the Spectrum and C64, it still managed to be the third biggest selling micro in the UK, with solid sales in Australia, Germany and Spain, and it was phenomenally successful in France, becoming the biggest selling micro there.

The 464 was followed by models such as the CPC664 and CPC6128, which featured 128K of RAM, and rather weirdly, an internal 3-inch (not 3.5!) floppy drive.

By the end of its life, the CPC had sold around three million units. Despite being discontinued in 1992, the last commercial title, *Megablasters*, was released in December 1994.

Emulation

If all you want to do is play a few games, for compatibility and ease of use, just use RetroArch. It's available on all major platforms and well supported. At the time of writing, there were two Amstrad cores available: Caprice32 and CrocoDS. Grab both.

The Caprice32 core generally gives the best results – it automatically loads files and generally gets out of the way. But it doesn't always pick the right file.

When loading disks with CrocoDS, it provides a menu from which you can choose a file name and select by pressing X. However, you can't really use most of the keyboard with CrocoDS, as it uses lots of shortcut keys, and Amstrad games frequently use the keyboard. If a game doesn't work with one core, use the other.

More bespoke, Retro Virtual Machine has a great interface but isn't stable enough yet, though it will be our first choice when the code is tightened. Windows users should also try WinAPE. But for now Caprice32 – the program the RetroArch core is based on – is the best choice across platforms.

Installation

Head to the website, where links and instructions are provided for both Windows and Linux: **https://github.com/ColinPitrat/caprice32**. Windows users are given a choice of a 32 or 64-bit zip file. There is no self installer, so you need to extract the zip file and manually open the executable, cap32.exe.

Linux users are provided a Snap, or masochists can build it from source. Depending on your distribution, the Snap should either be available in your software store, or you can follow the instructions at **https://snapcraft.io/caprice32**.

YOU'LL NEED
CAPRICE32
Both 32 and 64-bit versions are available. Linux users who don't have a native package available in their repositories need a distro with Snap support enabled.
https://bit.ly/39Ly6Du

Usage

Once Caprice32 has started, you are presented with the Amstrad's BASIC prompt. To load a disk image, press F1 to open Caprice32's system menu, and click the "Load/Save" button, which opens a new window. Under "File type" leave it as "Drive A (.dsk)" and leave "Action:" as "Load." Search for your Amstrad disk images in the file browser below, select your file, and click "Load." Back in the main menu, click "Resume" to return to the BASIC prompt.

Once a disk is loaded in an Amstrad (whether in real life or emulated), browse the disk by typing:

```
cat
```

This lists the files in your disk image – look for anything with the extension .BAS or .BIN. If there is a .BAS file, try that first; if it doesn't work, try a .BIN file.

To start a program, using ARKANOID.BAS as an example, drop the .BAS extension and enter:

```
load"arkanoid
run
```

If you're running a game that requires multiple disks, you're prompted to change or turn over the disk mid-program. Press F1, open the "Load/Save" menu, and choose the next disk image. Back in the main menu, click "Resume," and you should be OK.

On the off chance you find a tape file, press F1 and open the "Load/Save" menu as before. This time under "File type," choose "Tape," and click "Resume."

Back in the BASIC prompt, enter:

```
|tape
run"
```

The prompt now tells you "Press PLAY then any key:." Press F4 to engage the virtual tape mechanism, followed by any regular non-function key.

Wait a while and you're greeted by a loading screen with the same screaming noises old modems emitted. Go and make dinner, and when you return, your game may have finished loading. Use disks if possible. ■

Find software

As usual, **http://archive.org** has lots to offer; the "Amstrad CPC Game Collection By Ghostware" has a huge selection.

For an Amstrad-specific website, **http://cpcrulez.fr** is in a mixture of French and English, but you should be able to guess your way around. There are loads of ROMs – which we can't advocate – including both disk and tape dumps, but they also include freeware, public domain software, and demos, so we can at least recommend those.

For new games, **www.retroworks.es** has a couple of free titles, including *Teodoro no Sabe Volar* (2012), a great Spanish platformer thick with atmosphere and difficulty.

But there's nothing quite like the CPCRetroDev community, which keeps the Amstrad alive with a steady stream of new games, year after year. We particularly like *Baba's Palace* (2017), a fiendishly clever puzzle game with a fantastic theme tune, which combines *Sokoban*-style gameplay with platformer elements.

2012's *Teodoro no Sabe Volar* beautifully encapsulates the visually detailed but highly difficult platformers that typify the Spanish Amstrad scene.

DOWNTIME

Subnautica: Below Zero listed for PS5, Xbox Series X, and more

Subnautica: Below Zero might well be coming to current and next-gen consoles alike. Last month an ESRB rating for *Subnautica: Below Zero* appeared online (as first reported by *Gematsu*). What's noteworthy about the ratings page is that *Subnautica* is listed for PS4, PS5, Xbox One, Xbox Series X, and Xbox Series S, despite having only been previously announced for PC and Nintendo Switch.

Sonic has lost his voice

The voice of Sonic the Hedgehog, Roger Craig Smith, has finished up his ten year role leading one of gaming's most recognisable mascots. The actor hinted as much on Twitter in February, before Sega itself weighed in with the official news. "For over 10 years, Roger Craig Smith has been an integral part of the SEGA family," Sega wrote. "He brought the voice of Sonic to life, and we are forever grateful for his never-ending enthusiasm in helping the community and spreading joy." No reason was given, but it's a long ten year stretch to be the voice behind a fast-running videogame hedgehog. Nor does it signal the winding down of Sega's jewel-in-the-crown: Sega will reportedly release several new Sonic games throughout 2021.

GAMING NEWS

Google is closing its internal Stadia development studio

No more exclusive first-party content is planned.

Launched in November 2019, Google's Stadia game streaming service hasn't exactly taken the world by storm: it's not even available in Australia, even while Nvidia and Microsoft have both made inroads down under. Whether that's a factor in Google's closure of its internal game studio isn't a certainty, but it probably c an't help.

"Given our focus on building on the proven technology of Stadia as well as deepening our business partnerships, we've decided that we will not be investing further in bringing exclusive content from our internal development team SG&E, beyond any near-term planned games," Stadia boss Phil Harrison said in early February. Development op manager Jade Raymond, best known for co-creating *Assassin's Creed* and an aborted *Star Wars* project with EA, has left the company.

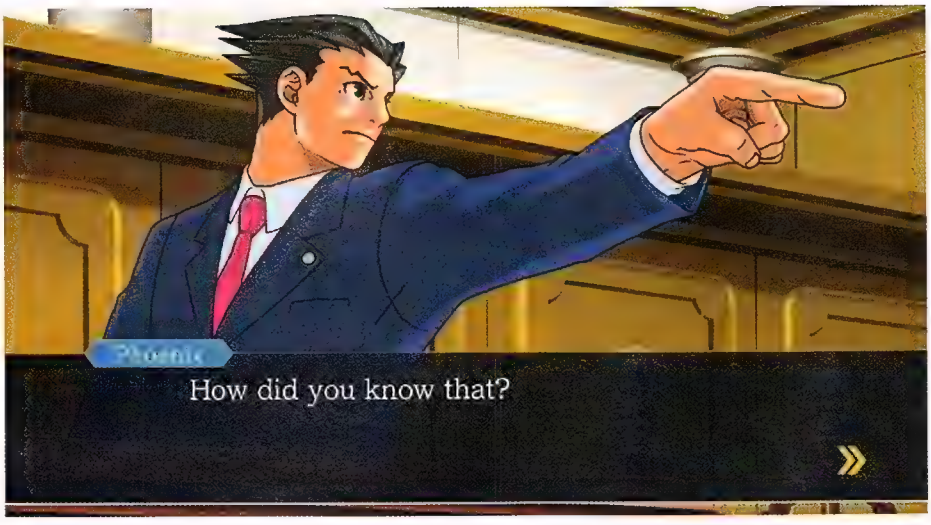
GeForce Now beta is coming to Australia in mid-2021

Beta registrations are open now.

Last month Nvidia announced that its game streaming service, GeForce Now, will roll out in Australia in 2021. It named Pentanet as the provider – a Perth-based ISP that currently only services Western Australia. Despite that ISP's location it's confirmed that the arrangement will service the whole country too, with the caveat that you'll need a decent connection for it to work.

Australians can register their interest in the service now on the Pentanet website, ahead of the mid-2021 beta, which will accept users from all over the country. Where connections are too unreliable or slow, Pentanet's Stephen Cornish said that "we won't shy from the challenge of building our own solution [next-gen wireless technology] we know to work, like we did for Perth."

Still, the infrastructure needs to keep up with these ambitions, so for now, GeForce Now servers will be in Sydney and Perth only for the beta. Cornish says in the announcement that beta registrations will influence the speed of deployment in other cities and states. "Gamers need to be close to our infrastructure, so our deployment strategy will be guided by level of demand across Australia, and potentially even New Zealand," he wrote.



Reddit user makes an *Ace Attorney* bot for heated arguments on the site

Reddit comments are the perfect place for an OBJECTION!

A *Phoenix Wright: Ace Attorney* bot is turning Reddit arguments into courtroom scenes from the game.

The bot was created by YouTuber Micah who uploaded a video of it in action, using the r/confession subreddit as an example. In the video, defence attorney Phoenix Wright and prosecutor Miles Edgeworth play out an argument found in the comments of a post. Maya Fey even makes an appearance as another user who has jumped into the thread.

Micah explains how the bot works at the end of his video stating that: The bot first checks for the most common Redditors in the comment chain, and applies the most common one to Phoenix, and the second most common to Edgeworth. It then loops through all the comments in the chain and checks the tone of each one. If the tone is negative, the bot will apply the game's famous catchphrase "objection!" and similarly, "if the tone is positive will apply a happy sprite".

The bot will then generate a video, upload it, and send a link to the user who commissioned it, which takes around 10 minutes to do.

"It then loops through all the comments in the chain and checks the tone of each one. If the tone is negative, the bot will apply the game's famous catchphrase "objection!" and similarly, "if the tone is positive will apply a happy sprite"."

Battlefield 6 may be "heavily influenced" by Battlefield 3, industry insider claims

Battlefield 6's maps are allegedly designed with "128 players in mind".

Battlefield 6 may be "heavily influenced" by *Battlefield 3*, according to industry insider Tom Henderson.

In a recent YouTube video (via altchar), Henderson summarises all of the details they claim to know so far about the next *Battlefield* game. Speculating that it will either be called *Battlefield 6* or simply *Battlefield*, Henderson says that the next title is "heavily influenced by *Battlefield 3*" and will be "somewhat of a soft reboot".

As pointed out in the video, Henderson has made the same claim in the past on Twitter, alleging that *Battlefield 6* will return to its modern-day setting on PC, PS5, and Xbox Series X, as well as PS4 and Xbox One. While the suggestion is made that it will be a soft reboot, Henderson addresses rumours doing the rounds about a full *Battlefield 3* remaster, saying there is no "concrete evidence" to suggest this is true.

Previously, the industry insider also said that *Battlefield 6* will feature 128 player maps.

New report suggests CDPR staff knew *Cyberpunk 2077* wasn't ready for release

Bloomberg reports that a number of current and former CDPR staff "depict a development process marred by unchecked ambition, poor planning, and technical shortcomings", alleging the team was aware of the issues ahead of release.

It further alleges that the 2018 E3 demo was "almost entirely fake".

Battleborn finally loses the fight against *Overwatch*

It feels like a century ago, but back in 2016 one of the biggest questions in gaming was: *Overwatch* or *Battleborn*? The former is a successful PvP hero shooter by Blizzard, the latter is an extremely unsuccessful hero shooter by Gearbox. The comparisons between the two were unfair: *Battleborn* was a cooperative focused first-person take on the MOBA. But it no longer matters whether it was actually good anymore, because now it's dead. Gearbox shut down the game's servers on January 31, not only rendering the online modes inactive but also the game's single-player campaign, which required an online connection to play.

"Heroes! It's been a hell of a ride, but all fights must end," Gearbox wrote. "The campaign and multiplayer are no longer available as the *Battleborn* servers are offline. Thank you for playing." If you own *Battleborn* on disc, it's now an elegant coaster. ■

"The complex, open-ended Berlin level is the most the studio has ever trusted a Hitman player to take the lead and figure things out for themselves"

$85 | PC, PS4/5, XB1, XSX/S, Switch | hitman.com

Hitman 3

The most creative and surprising assassination simulator yet.

We've finally come to the end of IO Interactive's so-called *World of Assassination* trilogy, which began with the Danish developer's first *Hitman* reboot back in 2016. These are some of the best systems-driven stealth games on PC, and *Hitman 3* tops the series off with a superb collection of levels – some of which are among the best in the entire series. This is a spiritual and mechanical continuation of the previous two games, but IO still has a few surprises up its sleeve.

Although *Hitman 3* builds on the foundations laid by the first two parts of the trilogy, sharing the same AI, stealth systems, and user interface, IO has also taken this opportunity to experiment with its tried and tested formula. The complex, open-ended Berlin level is the most the studio has ever trusted a *Hitman* player to take the lead and figure things out for themselves. And in the other levels there are, surprisingly, only three Mission Stories per map, compared to an average of about ten in the previous two games' levels.The opportunities are still there: elaborate traps to set up, people to pose as, shortcuts to take, keys to swipe. They just aren't as clearly signposted this time around, forcing you to engage more with the environment around you. At its core this is still very much a classic *Hitman* game, but in many ways a more playful, experimental one.

Hitman 3 opens with Agent 47 taking a trip to Dubai and infiltrating a glamorous soirée at the top of its tallest building. He enters the level by parachute, crawls through a window, slips into a tuxedo, and blends into the crowd, as if we needed any more proof that IO loves James Bond. It's a real visual treat too, with immense gilded palm trees, reflecting pools, and dramatic views over the cloud-covered city. But for all its glamour it's a rather simple, reserved level, feeling more like a tutorial to ease new or lapsed players into the game.

Despite a couple of weaker levels, *Hitman 3* is a sensational stealth game. Berlin, Chongqing, and Dartmoor represent the series at its best, which is a fine way to end the trilogy. And if you own the first two games you can access all of those levels here, with improved visuals and the ability to use the new game's gadgets and weapons in them. Do that, and this is easily one of the very best games you can play on PC today. If this was a review of the trilogy as a whole, I'd stick a couple more points on the review score. But even on its own, *Hitman 3* is a magnificent videogame and a perfect swansong for this incarnation of Agent 47.

ANDY KELLY

apc HOT PRODUCT

A beautiful, deep, and endlessly replayable murder sandbox, featuring some of the best levels in the series.

★★★★½

$29 | PC, PS4, XB1, 3DS, Mac | omori-game.com

Omori

A cutsey adventure is RPGmaker's latest cult horror hit.

The RPGmaker scene has dwindled over the years, making *Omori* feel like the ghost of a bygone era. But even though seeing the game's blocky visuals is like a blast from the past, this psychological RPG has all the makings of being a modern cult classic.

Omori follows the childhood antics of a group of kids during the summer break. The game is split into two realms: the dream world, where the group is searching for their missing friend, and the real world, where their regular lives play out. Led by a stone-faced boy called *Omori*, the group has light-hearted adventures, but there's an undercurrent of childhood trauma yet to be confronted.

When these horror elements reveal their distorted heads it's pretty scary stuff, but *Omori* balances it out with a dreamy fantastical world full of jokes, puns, and kooky characters. There's Pluto, the buff planet who loves to flex and teaches you moves for battle. Life Jam Guy, a riff on the Kool-Aid mascot whose enthusiasm for health items knows no bounds. Even the boss characters are funny, like Sweetheart, an obnoxious pop star who has a giant heart-shaped mace and cackles like an anime villain. Talking to every character in each area is worth every quip they share with you, although, due to RPGmaker's visuals, characters can easily get overlooked.

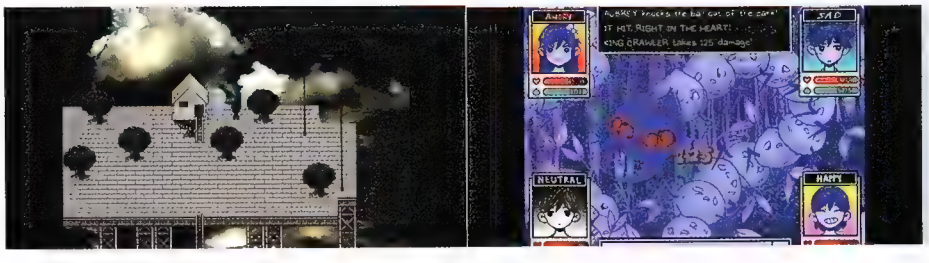
It's almost funny that out of this colourful cast of characters you get to play as the titular *Omori*, a quiet kid who lacks even a hint of a smile. But it's a little eerier than that. While *Omori*'s rag-tag group uses the likes of dodgeballs and spatulas in battle, *Omori*'s chosen weapon is simply a sharp knife which he cuts and stabs enemies with.

Children wielding deadly weapons aside, battles play out similarly to other turn-based RPGs – but *Omori* has a twist. It uses an emotional system where a character's feelings influence how they fight. Happy, sad, and angry work similarly to rock, paper, scissors, and each one enhances the characters in different ways.

RACHEL WATTS

Omori's ending is certainly brutal, but its characters and humour put some heart behind the horror.

★★★★☆



Free | PC, Mac, Linux
robustgames.itch.io/loco-motive

Loco Motive

Murder goes off the rails in this comedic mystery.

Loco Motive tells a measured, comedic murder mystery, brought to life with colourful characters, witty dialogue and puzzles that hit the sweet spot when it comes to difficulty.

The game takes place on a luxury steam train owned by the wealthy Lady Unterwald, who has come aboard to make a speech to her assembled family and employees. Naturally, she pegs it before said speech has even begun, and it's left to her personal lawyer Arthur Ackerman to solve her grisly murder, by retrieving the will he so carelessly loses at the start of the game. As Arthur, you'll chat to the suspects, solve puzzles, and generally enjoy a thrilling adventure. It's a complete story, but in miniature, requiring only around half an hour of your all-too-precious time.

You're not really given enough information or clues to be able to theorise about the murderer, and we never learn quite enough about the suspects for them to feel truly involved in the mystery. Still, its a charming and gorgeous period adventure game.

TOM SYKES

A great adventure game that's less great as a murder mystery, but still very worthy of your time.

★★★★☆

Free | PC | rbdinteractive.itch.io

Huldufólk

Brief but effective rural horror.

This is a PS1-styled horror game that features choreographed 3D cutscenes, a well-produced soundtrack, and a blocky, warped world dripping with rural atmosphere. All very impressive circa 1995, and really rather impressive again in 2020, when such nostalgia is usually inconsistent, or puddle-deep.

You play as an archaeologist dispatched to the Faroe Islands to survey a building site. The owner of the farmhouse you're staying at quickly fills you in on a local legend: of the huldufólk, or hidden folk, who are said to dwell on the islands, and who, he warns, are best left alone.

Before long, you arrive at the building site. You take a few spooky pictures, and then you head for an ominous cave. Before you know it the game is over, with one final, admittedly impressive cutscene. But it's so abrupt, and quite deflating after all that tense build-up. Perhaps the huldufólk could be convinced to appear in a sequel? I'd still recommend this to fans of folk horror.

TOM SYKES

There's a feeling of quiet dread here I've not encountered in many games.

★★★☆☆

$95 | PC, PS4/5, XBS/X | callofduty.com

Call of Duty: Black Ops – Cold War

Can't top *Warzone*...

Despite welcome adjustments to Create-a-Class and a fun (if brief) campaign, *Call of Duty* has been a lot better before. In fact, a better *Call of Duty* game released last year – the free-to-play battle royale madness of *Call of Duty: Warzone*. *Warzone*'s longevity makes *Cold War* a harder sell. There is no longer a single de facto *CoD*. As of December, Activision has unified progression across *Warzone* and *Cold War* with shared ranks, weapons, battle passes, and cosmetics. A rank gained in one will automatically carry into the other. Both games have prominent main menu buttons that launch into the other, seamlessly bringing your party along as well. By merging into a strange FPS homunculus, *Call of Duty* is, in its own way, evolving into a single service game hub with *Warzone* at its centre.

One of *Cold War*'s biggest problems is the time period itself. The '80s setting works in recognisable guns like the MP5 and M4, but the impact on attachments is noticeable. Since red dot and holographic sights were still early tech at the time, there are far fewer long-range options with clear laser sights. The omission of other offbeat modifiers like under-barrel launchers, weapon perks, and hybrid sights really stings. *Modern Warfare*'s weapons were malleable blueprints. In *Cold War*, I'm tweaking sliders without seeing or feeling a big result. The sense of discovery and experimentation is diminished.

Activision is in a confusing place with its proposed multi-*CoD* future. The publisher has its feet firmly planted in two camps – happy to update *Warzone* as a live service game, but still keeping a firm grasp on the annual release schedule. It's trying to thread that needle by selling *Cold War* like it's some sort of *Warzone* expansion pack. It's not, but it's just as unnecessary. I'm curious to watch the next year unfold as two conflicting shooters intertwine (at least until whatever's next). Who would've thought that *Call of Duty*'s biggest competition would be itself? Videogames are weird that way.

MORGAN PARK

An inessential distraction from the best *Call of Duty* on offer.

★★★☆☆

$29 | PC, PS4, XB1, Switch, Stadia | elhijogame.com

El Hijo

A charming stealth game that can't quite scratch out its own niche.

In *El Hijo*, the collectibles are orphaned children. The protagonist, a six-year-old unnamed boy, walks up to them and expands their world a little bit; maybe he teaches them to juggle, or how to fold a paper aeroplane. Those formerly despondent kids sparkle with joy, as a pop-up box informs the player that, thus far, they've 'inspired' one out of the four children in the level.

Broadly speaking, *El Hijo* is a stealth game. The boy explores 29 levels following a simple, wordless narrative about reconnecting with his mother after the family farm is razed by bandits. That journey will take you through stately monasteries, arid desert wastelands, and saloon shootouts. There is danger around every corner, and calamity can only be avoided by not being seen. And so, the boy is offered the standard Sam Fisher palette of abilities. He is nearly invisible in the shadows, and he can slink along the crates, boulders, and foliage with his head down to remain hidden. You will quickly acquire a slingshot, which can be used to cause distractions that will clear out guards from their pesky patrol routes.

El Hijo is a series of puzzles, rather than the anything-goes dynamism and improvisation that define most other modern stealth games. There is a clear and singular solution to evade many of the enemies in your path. A guard dog sits squarely in the exit. The only way to get him off his spot is to strike a scarecrow with a slingshot pellet, sending a flock of crows in his direction. He chases them off, and opens a brief window to paydirt. The puzzles are generally smart and constructed with care, but there were times that I wished that *El Hijo* felt more alive. Everything about its stealth is deeply mechanical.

I wish *El Hijo* were a tad bit snappier. That is the element *El Hijo* is missing: the decisiveness of action that makes you truly feel as if you've outsmarted the AI.
LUKE WINKIE

It's really quite difficult to play this without wishing for a little more flair in its stealth system.
★★★☆☆

Free | PC, Mac, Linux | powerhoof.itch.io

Intergalactic Wizard Force

Silly sci-fi fun.

This bizarre adventure game plays out like a half-remembered episode of He-Man, if it had been recreated by the folks behind *Rick and Morty*. You're the heroic Prince Xandar - a gullible beefcake - but also his crotchety wizard pal Maldrek, on whom he rides through space on a sort of intergalactic piggyback. It's a very 1980s sci-fi story: luridly colourful, visually arresting, and deeply, deeply silly.

After crashlanding on a planet, you have to get to the bottom of some disappearances, using the magical powers at Xandar and Maldrek's disposal. You'll get a few fun responses as you try these actions out in the world, and they're used in a handful of involving puzzles before you reach the ridiculous conclusion.

The magic comes down to the characters, the silly but cohesive world, and puzzles that cause you to investigate both planets deeply. I'd happily play more games featuring Xandar and Maldrek, particularly if they're as funny, stupid, smart, and slickly designed as this one.
TOM SYKES ■

Despite taking place on just a few screens, *Wizard Force* feels much bigger than it is.
★★★☆☆

The bird analogies are strong in *AC1*.

DEVELOPER UBISOFT MONTREAL **PUBLISHER** UBISOFT **RELEASED** NOVEMBER 13, 2007 **WEB** bit.ly/3o8MYzE

Assassin's Creed

Novel ideas save Altaïr from falling on his face. By Joseph Knoop

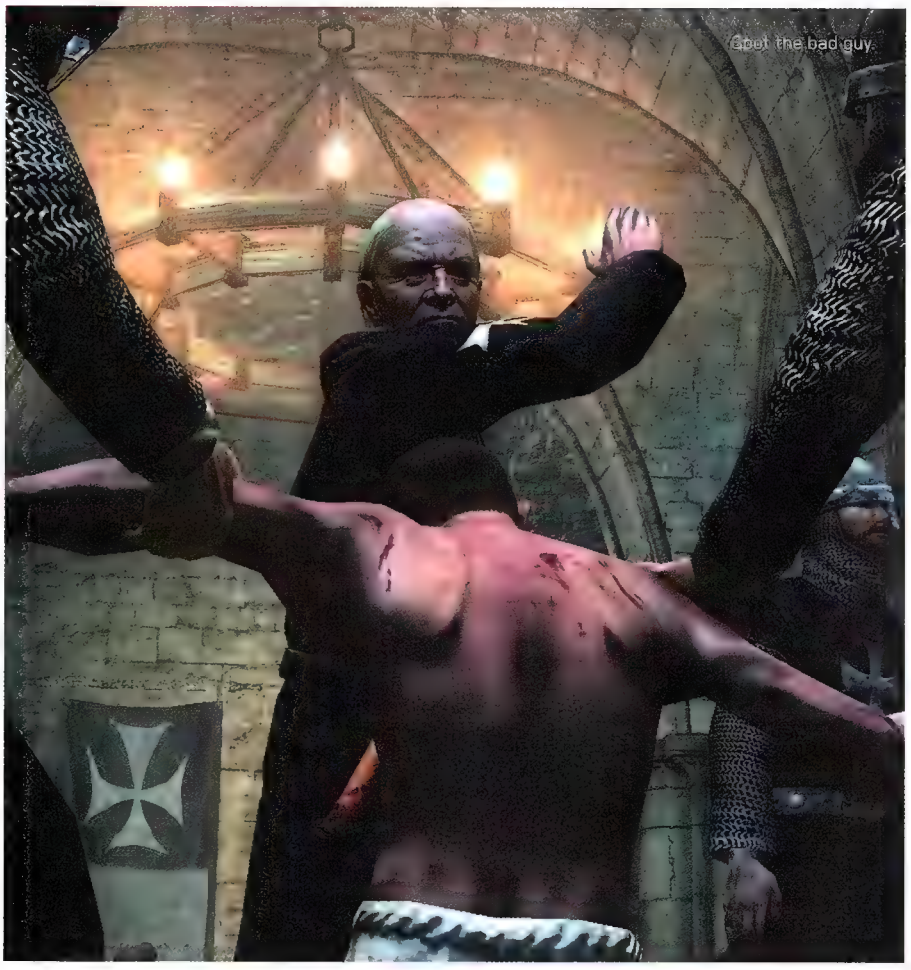
According to *Assassin's Creed*, the fine people of Damascus, Jerusalem and Acre only had about three lines of employment: carrying breakable vases on their heads, accosting citizens accused of petty crimes, or just getting 30 miles a day in on their medieval Fitbits. It's a far cry from the endless realms of *Valhalla*, *Odyssey* and *Origins*.

The original *Assassin's Creed* cares not for your RPG mechanics, however, fixating almost solely on exploring the world of the *Crusades*, collecting intel, and assassinating nine Templar leaders. I've contended for years that its brand of social stealth was where the franchise ought to have focused, rather than going bigger and bigger with each successive entry. I may have been wrong, though.

From the get-go, it's shocking to see an *Assassin's Creed* game where the protagonist is an unlikable dick. Future entries lived and died by how popular the player character was, and Altaïr is nothing short of a murderous bad boy. Within minutes of knowing him, he stabs an innocent old man in the back, gets one accomplice killed and the other dismembered, and mouths off to his elder like a teething child. When one of Altaïr's fellow assassins chides him for an unnecessary murder, saying "this is not the way," Altaïr responds with "my way is better," which sounds like a phrase you'd see on your 12-year-old cousin's T-shirt.

It doesn't help that Altaïr's voice actor could still land a Razzie by most modern standards. For a game that starts off with the trademark disclaimer about the team's multicultural makeup, hearing a distinctly American voice come out of an ancient Syrian feels like a weird betrayal of that commitment. To be fair, actor Philip Shahbaz is Iranian-American, but little of that identity seems to come through in Altaïr's progression as a character, which unconvincingly transitions from sour grape to remorseful curmudgeon with all the grace of a dead Templar.

Midway through his redemption, Altaïr's leader asks him how he knew he wouldn't kill him as punishment for screwing up. Altaïr's answer is simply, "I took a leap of faith". Woof. To its credit, the ultimate twist of Assassin's Creed's plot (Altaïr's mentor is corrupted by the mystical Apple of Eden, throwing the implied benevolence of the assassin brotherhood into disarray) massively pays off throughout the rest of the series. We like to harp on Ubisoft for being



'apolitical' with its storytelling, but the historical fiction of the Assassin vs Templar wars has provided for plenty of multilayered characters and motivations without it feeling like 'both sides' stupidity. Knowing the Brotherhood is fallible, makes its victories and failures that much more meaningful.

Side dishes

Assassin's Creed's strongest portions to this day remain the assassinations themselves. To get to them, though, you have to slog through a city's side missions, which include identical tasks like pickpocketing, beating up rabble rousers in alleys, or rooftop running time trials. That's it for variety, and the inclusion of hundreds of collectible flags doesn't help, but I did appreciate that reconnaissance missions actually gave me a small piece of intel that could, in theory, play into my final assassination.

An early bit of investigation led me to discover that my target, a Templar surgeon in charge of a ward full of mentally ill people, often focuses on his patients to the detriment of his immediate surroundings, making him an easier target. It's nowhere near the depth of more immersive games, like stumbling upon some casual cannibalism in a *Fallout 3* town, but it does give you a little more familiarity with your target. Not enough to feel anything terribly personal towards them,

Top right: Not suspicious, not suspicious at all!

BEHIND THE HOOD

Assassin's Creed's surprisingly notable actors

KRISTEN BELL
VOICES: Lucy Stillman
SEEN IN: *Frozen, The Good Place, Veronica Mars*

NOLAN NORTH
VOICES: Desmond
SEEN IN: *Uncharted, Destiny, The Last Of Us*

PHIL PROCTOR
VOICES: Warren Vidic
SEEN IN: *Monsters Inc, Tarzan, Rugrats*

but that's where another part of *Assassin's Creed* comes in to play.

Though these days it feels like Ubisoft is more known for huge open worlds, it's impossible to miss how *Assassin's Creed* influenced the arc of post-2007 storytelling. Each assassination mission kicks off with a cinematic introduction to your target just as you walk up, almost never ripping away from your perspective. When Altaïr finally plunges the good ol' wrist-blade into his back, players are treated to a sort of side-stage conversation between the two. Each victim gets their monologue, ripping into Altaïr with the bravado you'd expect of a villain, but also with the genuine grief that he could not see the world the way they did.

Though future entries did it with more flair, it's striking that *Assassin's Creed* was confident enough in its storytelling to sow seeds of doubt in its player. But what is a narrative without a world to tell it in? It's crazy to think that Ubisoft believed it

could get away with designing three major cities, an assassin village and a sizeable overworld connecting it all.

City slicker

And you know, Ubisoft didn't get away with it. Despite Jerusalem, Damascus and Acre being very different regions, each city feels bereft of cultural signifiers besides one or two notable landmarks, like the Dome of the Rock in Jerusalem or the port in Acre. Even worse, each city was seemingly built by the same architect, each building a basic square or triangle as if shunted into place like a Lego block rather than naturally layered over the years. This makes each place feel far too similar to the last.

I wonder too how confident Ubisoft was in its climbing tech at the time, considering Altaïr gets tripped by anything other than a 90-degree angle. There's nothing quite like leaping over three support beams, swinging through a merchant's stand with some impeccable animation, and eagle-diving into some hay.

The crowd loves a show.

Consider me still very impressed by the controls, where Ubisoft assigned each side of your body to your controller's face buttons. It forces you to be conscious of how you're using your body in the moment, be it to shove a man out of the way or sidle around his guard. Nowadays, even Valhalla relies on a fairly standard light and heavy attack system that only considers your body when it's time to dual-wield shields.

Then there's the overworld that connects the cities, a large yet surprisingly linear procession of huts and military camps bookmarked only by more towers to climb. It's weird because it shows the scope of Ubisoft's ambition years before it would really nail it. I'd wager it was meant to house much more to do, but instead we just get some innocuous horseback riding.

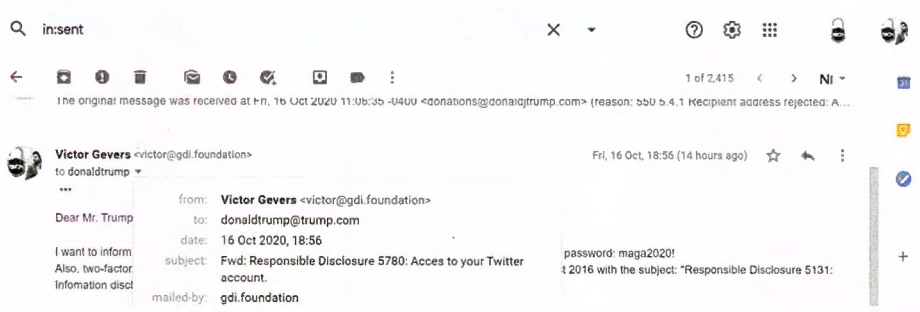
There's also a number of NPCs that haven't aged well, including the homeless people exhibiting signs of mental illness who violently shove you, or the small army of beggars that always happen to be women. To Ubisoft's credit, the cast is well-rounded with (mostly male) actors representative of each region.

I realise I've spent much of this ragging on *Assassin's Creed*, but it's easy to see why this franchise took off the way it did, save for a few resets. Hitman was already on the scene as a sort of social stealth experience, but *Assassin's Creed* was truly a next-gen horsepower showcase, and it wasn't afraid to show that off. The camera is closer to the player, more intimate, and not so much the typical third person of recent tries. The pacing is nowhere near the breakneck speed of Valhalla, but to see Middle Eastern cities realised so expansively was groundbreaking for the time.

Assassin's Creed is a testament to Ubisoft's strengths as a studio, where scope was just a word and every gamer's natural instinct for historical murder tourism can be explored with some genuine zeal. Altaïr may be a fumbling mess at many times, but he walked so we could run. ■

CHIP CHAT

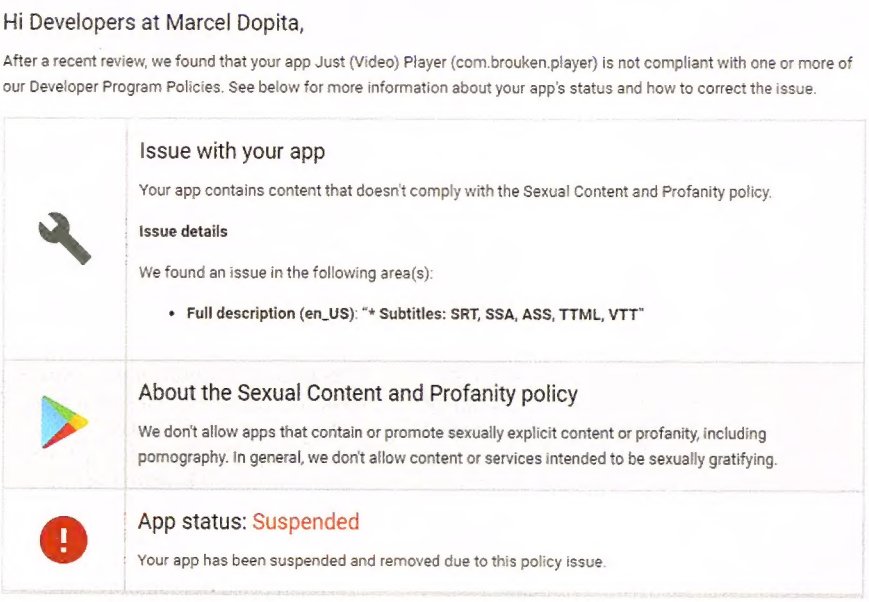
JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS



Dutch inquiry finds hacker just guessed Trump's simple Twitter password

It doesn't take a genius to guess maga2020!

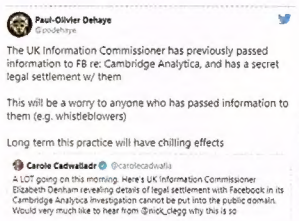
An inquiry by Dutch prosecutors into the hacking of Trump's Twitter account on October 16th 2020 uncovered that Victor Gevers simply guessed the former president's top secret password: maga2020! While hacking is a criminal offence in the Netherlands, Grevers' public disclosure of the hack means he was able to avoid prosecution under an 'ethical hacker' clause, a loophole that promotes better security protocols in a similar way to bug bounties. Despite the inquiry, both Washington and Twitter denied that Trump's Twitter account was ever compromised. Trump also, ironically, claimed in a public address on October 20th that "Nobody gets hacked. To get hacked you need somebody with an IQ of 197 and he needs about 15 percent of your password."


Hi Developers at Marcel Dopita,
After a recent review, we found that your app Just (Video) Player (com.brouken.player) is not compliant with one or more of our Developer Program Policies. See below for more information about your app's status and how to correct the issue.
Issue with your app
Your app contains content that doesn't comply with the Sexual Content and Profanity policy.
Issue details
We found an issue in the following area(s):
Full description (en_US): "* Subtitles: SRT, SSA, ASS, TTML, VTT"
About the Sexual Content and Profanity policy
We don't allow apps that contain or promote sexually explicit content or profanity, including pornography. In general, we don't allow content or services intended to be sexually gratifying.
App status: Suspended
Your app has been suspended and removed due to this policy issue.

Google's automated app reviewer finds subtitle file name rude

Google review bot thinks .ass files are too hot to handle.

Google's automated app review process banned the Just (Video) Player for breaching its Sexual Content and Profanity policy, after the app updated a tiny subtitle support description. It seems the Advanced Sub Station alpha file name (.ass) triggered Google's naughty-word filter and automatically pulled the app from the store. The developer filed an appeal and the app was available on the Google Play Store again soon after. While the Sub Station Alpha subtitle editor is now abandonware, the .ass file type is still maintained by many leading video players including VLC and Google's own Android video player.


Paul-Olivier Dehaye
The UK Information Commissioner has previously passed information to FB re: Cambridge Analytica, and has a secret legal settlement w/ them
This will be a worry to anyone who has passed information to them (e.g. whistleblowers)
Long term this practice will have chilling effects
Carole Cadwalladr @carolecadwalla
A LOT going on this morning. Here's UK Information Commissioner Elizabeth Denham revealing details of legal settlement with Facebook in its Cambridge Analytica investigation cannot be put into the public domain. Would very much like to hear from @mick_clegg why this is so

UK watchdog gagged over Facebook app audit progress

FACEBOOK MAKES A DEAL TO MANAGE ITS OWN CAMBRIDGE ANALITICA INVESTIGATION.

A few years ago, in the lead up to the US Senate hearing on the Cambridge Analytica scandal, Mark Zuckerberg promised to audit any suspicious apps with access to large amounts of Facebook data in a post on his personal Facebook profile, but a settlement with the UK data watchdog may mean that never happens. The UK's information commissioner, Elizabeth Denham, indicated in January that she was not able to comment publicly on the state of the Facebook app-audit during a parliamentary subcommittee since her office had struck an agreement that was 'not in the public domain' and restricted her ability to comment on the matter.

Castle of Lions PC build a blast from the past

VOLTRON CASTLE THAT'S ACCEPTABLE FOR KIDS IN THE 80S.

PC case builders and fully-grown *Voltron* fans will be excited about a new build by local case modder, *APC* reader and Redditor u/robdp82 who converted a retro Castle of Lions toy into a Mini-ITX PC. The 80s *Voltron* cartoon franchise build took over three and a half years to fully piece together using the now-collectors-item toy frame components, but considering it's got custom sticker plating on the GPU and all four M.2 drive slots, and a Voltron head power button, we're not surprised this extremely detailed project took some time.

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